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UNITED STATES DEPARTMENT OF AGRICULTURE • Economic Research Service

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(Continued on inside back cover.)

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Income Parity Standards for Agriculture

By Robert H. Masucci

Parity, or "equality for agriculture," has long been a goal for farmers. Several definitions of parity have been used as a guide to the well-being of farmers, as a basis for the farm programs of the Government, and as a guide to general economic programs aimed at high levels of employment, production, and purchasing power. Yet none has proved entirely satisfactory. Parity has been elusive to define and difficult to measure—especially in the postwar period of rapid changes in agriculture and in the rest of the economy. Farmers, agricultural economists, Congressmen, and many others have frequently criticized the measures of parity currently in use. Congress has found it necessary from time to time to direct changes in parity computations to make programs workable, or to avoid serious inequities. The article presents a new concept of income parity standards for agriculture. Other studies were made in the past by the Department, and Iowa State University recently published a study, *An Alternative Parity Formula for Agriculture,* Research Bulletin 476.

SINCE THE MID-1950's the rate of change in the structure of agriculture has accelerated markedly. The advance in the rate of productivity in 1954–59 was almost double that of the preceding 5-year period. From the Census of Agriculture we find that the number of farms selling $5,000 and more continued to rise between 1954 and 1959. Farms with value of sales of less than $5,000 declined by almost 30 percent, even after allowing for the reduction in numbers due to the change in definition of a farm. Thus developments in the size structure of agriculture continue to be characterized by (1) a relatively stable number of commercial farms, which are for the most part family owned and operated, and (2) a continuing decline in the number of smaller scale farms whose operators are turning more to nonfarm pursuits.

This is illustrated by table 1, which shows average net family income, by major economic classes, from farm and off-farm sources. Total family income includes (1) the net cash income received by the farm operator for farm capital investment, and for his and his family's management and labor; (2) non-money income from the farm from the use of the farm dwelling and farm furnished food; and (3) income received from off-farm sources, such as wages the operator and members of his family receive from other jobs.

Average total family income for the two top classes, which include farms with value of sales of $5,000 and more, was $7,763 in 1959. This is about the same as the $7,785 average for non-farm families, but the average farmer in this category had an *investment in productive assets* of over $84,000. For farms with sales of less than $5,000 total family income averaged $3,750. Net cash farm income for the two top classes substantially exceeded off-farm income, but was lower for the other classes.

It seems clear that the income problems of farms in the classes with sales of $5,000 and more are different from those of the other groups. These farms represent commercial agriculture. They account for 87 percent of the total value of farm products sold and thus are the chief recipients of the benefits of our commodity price and income support programs. Farms with sales of less than $5,000 have had to rely more and more on nonfarm opportunities to improve income status.

Legislation enacted in 1936 and in 1938 defined income parity in terms of the maintenance of a historical ratio between the per capita income of the farm population and that of the non-farm population. The 1936 legislation defined income parity in terms of the per capita income of the farm population from all sources, both farm and nonfarm, while the 1938 legislation related to income from farming operations only. Both concepts referred to the entire farm population, including hired workers.

Despite the fact that average per capita farm income for all farms combined has been much lower than the average per capita income of nonfarmers, per capita farm income for 1959 was at or above income parity under either of the above definitions. Calculations based on the old definition of a farm and unrevised estimates of the farm

TABLE 1.—*Average net income of farm operator families, by major economic classes, U.S., 1959*

Economic class	Number of farms 1959		Percent of sales of farm products	Average net income of farm operator families			
	Total	Percent of total		Net cash farm income [1]	Off-farm income	Total cash income	Total income including non-money income from farm food and housing
Commercial:							
Farms with sales:	*000*	*Percent*	*Percent*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
$10,000 and over	795	21. 5	71. 9	6, 636	1, 978	8, 614	9, 960
$5,000 to $9,999	654	17. 6	15. 4	2, 165	1, 567	3, 732	5, 018
$2,500 to $4,999	618	16. 7	7. 4	1, 288	2, 077	3, 365	4, 572
$50 to $2,499	349	9. 4	1. 5	438	525	963	1, 476
Other farms:							
Part-time [2]	888	23. 9	2. 7	176	4, 283	4, 459	4, 890
Part-retirement [3]	404	10. 9	1. 1	116	1, 846	1, 962	2, 363
Farms with sales $5,000 and over	1, 449	39. 1	87. 3	4, 618	1, 826	6, 444	7, 763
Farms with sales of less than $5,000	2, 259	60. 9	12. 7	510	2, 589	3, 099	3, 750
All farms	3, 708	100. 0	100. 0	2, 115	2, 247	4, 362	5, 275

[1] Cash receipts from farm marketings plus Government payments less production expenses.
[2] Value of sales less than $2,500, operator under 65 years of age and either worked off farm 100 days or more or income of family from non-farm sources greater than value of products sold.
[3] Value of sales less than $2,500, operator 65 years or older.

population showed per capita income of the farm population in 1959 to be about at parity with the non-farm population. When the new definition of a farm and farm population estimates consistent with it were used, the 1959 per capita income of the farm population was about one-fourth above income parity.

In this paper we are exploring the possibility of comparing the returns to investment and to labor in agriculture to returns to similar resources outside of agriculture. For this purpose, we are considering two groups of farmers: First, commercial farmers whose sales total $5,000 or more; and, second, non-commercial farmers with total sales of less than $5,000. In effect, this approach would divide goals and programs to meet income problems of farmers into two "packages," each designed to measure the income difficulties of the two distinct operator groups in agriculture.

For the first group we apply a concept which calls for returns to investment and operators' and family labor comparable to returns received in the non-farm economy. The goal or standard would be parity of returns to efficiently employed resources used in commercial production. This goal in effect states that farmers who operate on a relatively large-scale basis should receive rates of returns for their labor and capital equal to the average rates received by non-farm resources employed in non-farm pursuits. Commodity oriented price or income programs may then be developed to help commercial farmers to meet such income goals or standards.

For the second group—those selling less than $5,000—it may be appropriate to have an income goal or standard equivalent to average income of non-farm families. This goal would be achieved through programs for full development of rural resources. Although well-conceived commodity programs will help alleviate the income problem of this group, only one dollar out of every five earned as cash income by such families is derived from the farm.

The main emphasis of this study is on the development of a parity of returns standard for commercial farms.

The concept of parity of returns developed in the present study is defined as follows:

TABLE 2.—*Parity returns to commercial farmers, 1961* [1]

	Millions of dollars
1. Productive investments in commercial agriculture—5% returns on $134,533	= 6,726
2. Hired Labor—2,532 million man-hours at $1.25	= 3,165
3. Labor of operators and their families—3,299 million man-hours at $2.32	= 7,654
4. Parity returns to commercial farmers	=17,545
5. Actual income originating in commercial agriculture	=14,495
6. The gap (difference between parity returns and actual income)	= 3,050
7. Gross income of commercial farmers	=34,111
8. Percentage increase required in gross income	= 9

[1] Farms with value of sales of $5,000 and over.

Parity returns to commercial farmers are those required to make the rate of return to labor and capital in commercial agriculture in the aggregate equal to the rate of return to comparable labor and capital in other segments of the economy.

The advantages of this definition will be developed in more detail later. Here, we shall comment only briefly on four aspects of the definition.

First, this is a concept of *parity returns* rather than of *parity prices*. Income is a better measure of well-being of farmers than prices alone. Of course, in carrying out farm programs, parity returns could be translated into prices.

Second, the definition applies only to commercial farmers—those who make most of their living from agriculture. It is not feasible to devise a measure of adequate incomes *from farming* for *non-commercial* farmers since their income problems are not met satisfactorily by commodity programs. Programs for the development of rural resources offer a better approach.

Third, the definition is in terms of equality of rates of earnings. It is based upon the earnings of the commercial farmer as a worker and as a businessman with a large investment.

Finally, the definition is in terms of the aggregate of income for all commercial farms combined, rather than by commodity, by type of farm, or by region.

The concept of parity returns as described above can be measured objectively. For example, the computation of parity returns for 1961 would be as shown in table 2—allowing 5 percent return on investment, the Federal minimum wage of $1.25 an hour for hired labor, and the average factory wage rate of $2.32 an hour for the labor of operators and their families. The computed parity of return for 1961 is 9 percent above actual returns to resources used in commercial agriculture in that year.

Legislative History of the Parity Concept

The unit of purchasing power approach to parity upon which the present parity price formula is based has been essentially unchanged for more than a quarter century. The present official parity index—the index of prices paid by farmers, including interest, taxes, and wage rates—has been somewhat modified over the years. Refinements have been made from time to time to adjust weighting periods and to add features designed to improve the index as a tool for helping to achieve the initial objective of "parity" for farmers.

Essentially, the unit of purchasing power concept of parity is simple. It was quickly seized upon by those concerned with the pressing problems of farmers. This often happens with simple concepts in periods requiring urgent action.

This notion of parity was included in the Agricultural Adjustment Act of 1933. The word "parity" was not used, but the concept of unit purchasing power was implicit in the stated objective, "to reestablish prices to farmers at a level that will give agricultural commodities a purchasing power with respect to articles that farmers buy, equivalent to the purchasing power of agricultural commodities in the base period. The base period in the case of all agricultural commodities except tobacco shall be the prewar period, August, 1909—July, 1914. In the case of tobacco, the base period shall be the postwar period, August 1919—July, 1929."

The word "parity" was first used in legislation in the Agricultural Adjustment Act of 1938 in which the stated purpose was "assisting farmers to obtain insofar as practicable, parity prices for such commodities and parity of income . . ." In general, the act provided for: (1) Specific adjustments in the computation of the parity index, such as those calling for the inclusion of new items; (2) the computation of "comparable prices" for items for which price data were nonexistent during the base period, since such commodities at that time were not produced in sufficient quantities; and (3) adjustments to take into account changing relationships over time among the prices of individual agricultural commodities.

The concept of parity in terms of unit purchasing power was generally recognized as being of only limited usefulness as a guide for achieving parity of income. This was reflected in the fact that the concept of income parity was included in several pieces of legislation beginning in 1936.

For example, the Soil Conservation and Domestic Allotment Act of 1936 declared as its purpose the "reestablishment, at as rapid a rate as the Secretary of Agriculture determines to be practicable and in the general public interest, of the ratio between the purchasing power of the net income per person on farms and the income per person not on farms that prevailed during the 5-year period, August, 1909—July, 1914, inclusive, as determined from statistics available in the United States Department of Agriculture, and the maintenance of such ratio."

For practical purposes, this definition of income parity proved ambiguous—so much so that a new definition was embodied in the Agricultural Adjustment Act of 1938. This legislation included the following: " 'Parity,' as applied to income shall be that per capita net income of individuals on farms from farming that bears to the per capita net income of individuals not on farms, the same relation as prevailed during the period from August, 1909—July, 1914."

This definition made it much simpler to compute a measure than the earlier one did since it merely required that ratios of per capita net income of persons on farms from farming to per capita net income of persons not on farms be computed for the base period specified and for subsequent years. However, it still fell short of achieving general acceptance as a measure of income parity which represented an equitable share of the total national income for farmers. As a result, the definition was changed again in the Agricultural Act of 1948, which read that " 'Parity,' as applied to income shall be that gross income from agriculture which will provide the farm operator and his family with a standard of living equivalent to those afforded persons dependent upon other occupations."

That Act also applied the concept of parity income to individual commodities, stating that " 'Parity,' as applied to income from any agricultural commodity for any year, shall be that gross income which bears the same relationship to parity income from agriculture for such year as the average gross income from such commodity for the preceding ten calendar years bears to the average gross income from agriculture for such ten calendar years." This provision for individual commodities depended upon a determination of parity gross income, which in turn, required a measurement of gross income. In addition, measures of differences in levels of living as between persons living on farms and those not living on farms were required. The difficulties of computation involved in making such definitions meaningful were so great that, to date, measurements under the provision of the Act have not been attempted.

To summarize, enacted legislation to date has incorporated the following concepts of parity: (1) Price parity, or unit of purchasing power parity; (2) income parity based on the historical ratio of the *purchasing power* of the net income per person on farms to income per person not on farms; (3) income parity based on merely a historical ratio, regarded as normal, of the per capita net income of individuals on farms from farm operations to the per capita net income of individuals not on farms; and (4) income parity based on equality of incomes in absolute terms with adjustments for differences in living standards.

Parity of Returns Alternative to Unit of Purchasing Power Parity

Generally speaking, the unit of purchasing power concept of parity is relatively simple in terms of definition, scope, and practical measurement. Moreover, the experience gained in almost 30 years of its application plus the many refinements made in the construction of the indexes of prices paid and prices received by farmers give it

a sanction of historical practicability. This does not mean, however, that the concept and measures now in use should not be continuously examined and reappraised in terms of whether they are performing the function originally conceived for them and, if not, whether new concepts and measures might be substituted.

The present parity concept has been continuously appraised by agricultural specialists during the years it has been in use. Some have cited several major limitations, including (1) remoteness of the 1910–14 base for the indexes of prices paid and received by farmers; (2) failure to reflect cost rates for individual commodities by applying the index of prices paid, including interest, taxes, and wage rates, to all agricultural commodities; (3) unresponsiveness to changes in input composition even for all of agriculture combined because the parity index reflects changes in prices of inputs, but not quantities; and (4) failure to measure the income position of farmers either absolutely or relatively, since the parity price ratio reflects only the purchasing power of a unit of farm commodities relative to its purchasing power in a base period.

These limitations have led to several investigations into the feasibility of developing alternative concepts of parity and methods of measuring it. In 1957, pursuant to Section 602 of the Agricultural Act of 1956, the U.S. Department of Agriculture reported to the Senate the results of a comprehensive study of possible methods of improving the parity formula.[1] More recently, a comprehensive study of an alternative parity formula for agriculture was made by staff members of Iowa State University under a subproject of the Interregional Committee on Agricultural Policy.[2]

This paper utilizes aggregative data on farm income and on selected farm balance sheet items to develop a standard of parity returns to resources used on commercial farms with a value of sales of $5,000 or more. This involves the determination of (1) the composition of resources on which parity of returns are to be sought, and (2) average rates of return to inpute to such resources.

With respect to the composition of resources, questions arise as to whether we should include hired workers, resources owned by landlords as well as owner operators, and borrowed capital as well as equity capital.

The unit of purchasing power standard involves the average price relationship of all inputs to that of all outputs. Theoretically, therefore, it covers all capital resources and all labor inputs; that is, all factors of production in agriculture are included whether such factors are hired workers, nonfarm or farm landlords, and nonfarm holders of claims against farmers. The labor of hired workers, and the resources of non-farm landlords and non-farm holders of claims all constitute resources employed in agriculture, but they are not owned or provided by farm operators or their families. Under the parity returns concept, the question arises as to whether these factors also should realize parity of returns for their contributions.

All of the above resources are included in the total of resources employed for purposes of developing the parity of returns standard used in this study. They all contribute either labor or capital to the production process.

Rates of returns for operator and family labor were considered to be parity returns rates if they equalled the average hourly earnings of all employees in manufacturing. This was based on the assumption that the degree of skills required to perform farm operations is on the average somewhat lower than that of employees in manufacturing, but that the management function performed by operator and family labor just about offsets this difference in skills. For hired labor, on the other hand, a rate equal to the prospective minimum wage of $1.25 was employed. Such a rate would permit farmers to pay hired workers the national minimum wage rates already provided for other groups of workers in existing legislation.

For farm capital or productive assets the computations of parity of returns for 1961 assume a rate of 5 percent. This was about equal to the weighted average interest rate paid on all farm mortgage loans outstanding in 1961, but somewhat lower than the rate of interest on new mortgage loans.

[1] For details of this report, see *Possible Methods of Improving the Parity Formula.* Report of the Secretary of Agriculture Pursuant to Section 602 of the Agricultural Act of 1956, Senate Document No. 18, 85th Congress, 1st Session, 1957.

[2] See *An Alternative Parity Formula for Agriculture.* Research Bulletin 476, Agricultural and Home Economics Experiment Station, Iowa State University, Ames, Iowa, February, 1960.

TABLE 3.—*Estimated income originating in agriculture, parity of returns to agricultural resources, and increases in gross farm income necessary to achieve parity of returns by major sales classes, 1961*

	Farms with sales				
	Over $5,000	$2,500 $4,999	Over $2,500	Under $2,500	All farms
1. Number of farms—thousands	1,550	560	2,110	1,701	3,811
2. Cash receipts from farm marketings plus government payments—dollars in millions	32,549	2,190	34,739	1,997	36,736
3. Value of home consumption—do	583	183	766	413	1,179
4. Rental value of farm dwellings—do	979	223	1,202	804	2,006
5. Gross farm income, lines (2)+(3)+(4)—do	34,111	2,596	36,707	3,214	39,921
6. Production expenses—do	24,410	1,282	25,692	1,417	27,109
7. Realized net farm income, line (5)—line (6)—do	9,701	1,314	11,015	1,797	12,812
8. Total wages of hired workers—do	2,822	104	2,926	122	3,048
9. Net rent paid to nonfarm landlords—do	877	76	953	154	1,107
10. Interest paid by farmers—do	1,095	95	1,190	193	1,383
11. Total net income originating in Agriculture, lines (7)+(8)+(9)+(10)—dollars in millions	14,495	1,589	16,084	2,266	18,350
12. Total productive assets in Agriculture—do	134,533	14,094	148,627	29,773	178,400
13. Total labor used—million hours	5,831	1,247	7,078	3,058	10,136
(a) Hired workers—do	2,532	93	2,625	110	2,735
(b) Operators and family workers—do	3,299	1,154	4,453	2,948	7,401
14. Estimated parity returns on productive assets plus labor: Assuming 5.0 percent yield on assets, minimum wage of $1.25 per hour paid hired labor and $2.32 per hour return for operator and family labor—dollars in millions	17,545	3,498	21,043	8,466	29,509
15. Estimated income gaps: Line 14—line 11—do	3,050	1,909	4,959	6,200	11,159
16. Indicated percentage increases in gross income required: Line 15 ÷ line 5—percent	+9	+74	+14	+193	+28

While rates employed for labor and capital in this study are believed to be close to what may be considered reasonable, they are by no means the only rates for which a strong and reasonable case might be made. They do, however, provide a reasonable illustration of how the standard of parity of returns might be developed computationally.

Some idea of the range of the computed adjustments necessary to achieve parity of returns under different assumptions of rate of returns may be obtained by comparing the results shown in table 3 for farms with sales of $5,000 and over, with results of computations using different assumptions. For example, if a 3.5 percent return were imputed to productive assets on farms with sales of $5,000 or more, instead of the 5 percent used in table 3, and if labor returns were assumed to be the same as in table 3, an adjustment percentage in gross income of about 3 percent is indicated. This compares with the 9 percent adjustment shown in table 3 for farms with value of sales $5,000 and over.

If, in addition to an imputed rate of return to farm capital of 3.5 percent, we were to assume that hired labor were to be paid the actual average composite wage for such labor in 1961 of 83 cents per hour, an adjustment of less than 1 percent is indicated.

One further observation is appropriate at this point. The parity returns standard computed on the basis of aggregative data relates to all commercial farms combined. This implies a concept of an average farm. It does not purport to measure parity of returns for each and every farm within the group, or even the different types of farms within the group. It merely represents income adjustments necessary for an average commercial farm to realize parity of returns for resources used. For farms of above-average efficiency such indicated adjustments may well result in windfall returns above the indicated average. For those below, it will tend to encourage efficiency of operations so that they too can realize parity of returns on efficiently utilized resources.

TABLE 4.—*Per farm estimated income originating in agriculture, parity of returns to agricultural resources, and increases in gross farm income necessary to achieve parity of returns by major sales classes, 1961*

	Farms with sales				
	Over $5,000	$2,500 $4,999	Over $2,500	Under $2,500	All farms
1. Gross farm income: Item 5, table 3 ---- dollars	22,007	4,636	17,397	1,889	10,475
2. Total net income originating in Agriculture: Item 11, table 3 ---- dollars	9,352	2,838	7,623	1,332	4,815
3. Total productive assets in Agriculture ---- do	86,795	25,168	70,439	17,503	46,812
4. Total labor used ---- hours	3,762	2,227	3,354	1,798	2,660
(a) Hired workers ---- do	1,634	166	1,244	65	718
(b) Operators and family workers ---- do	2,128	2,061	2,110	1,733	1,942
5. Estimated parity returns on productive assets plus labor: Assuming 5.0 percent yield on assets, minimum wage of $1.25 per hour paid hired labor and $2.32 per hour return for operator and family labor ---- dollars	11,319	6,246	9,973	4,977	7,743
6. Estimated income gaps: Line 5 — line 2 ---- do	1,967	3,408	2,350	3,645	2,928
7. Indicated percentage increases in gross income required: Line 6 ÷ line 1 ---- percent	+9	+74	+14	+193	+28

Computation of Measures of Parity Returns

Tables 3 and 4 illustrate, for the year 1961, the measurement of gaps between actual returns to capital and labor resources used in agriculture and parity of returns to such resources with those employed in nonagricultural enterprises.

Such measurements are shown by major sales groups and for all groups combined in aggregate dollars in table 3, and on an average per-farm basis in table 4.

In table 3, actual returns to resources used in agriculture, or net income originating in agriculture (line 11) consist of (1) the realized net income of farm operators (line 7), that is, net returns to farm operators for their labor, management, and capital; (2) total wages of hired workers (line 8); (3) interest paid by farmers (line 10); and (4) net rent to nonfarm landlords (line 9). In concept, these are all shares distributed to productive factors for either their labor or their capital contribution.

For the computations of returns to resources two measures were required: Total productive assets used in agriculture (line 12)—farm real estate, farm machinery and equipment, farm product inventories and an allowance for working capital—and total man hours of labor, both hired and family, required for farm production in 1961 (line 13). Unit rates of return for capital and labor were applied to the total productive assets and labor used in agriculture in 1961 to derive estimates of comparable or parity returns. Line 14 in table 3 shows the results of these computations and represents *parity returns to agricultural resources* for the different economic classes of farms and for all farms combined. For these computations, hired labor was assumed to be paid the prospective minimum wage of $1.25 per hour, while operator and family labor were assumed to be paid at the factory wage rate of $2.32 per hour.

Line 15 shows the estimated gaps that existed in 1961 between actual returns to resources used in agriculture and parity of returns to agriculture as shown in line 14. Such estimated gaps in aggregative dollar terms are then divided by actual gross farm income in 1961, and shown in line 16 as the indicated increases in total gross income in 1961 necessary to achieve parity of returns to resources employed in agriculture.

Parity of returns standards for individual types of farms, or even for major commodities, is an alternative to the development of a parity of returns standard for all farms combined. The Iowa State University study uses this type of farm approach, utilizing the regularly published data for commercial farms, by type and location, covered in the U.S. Department of Agriculture's Farm Costs and Returns Series.

The computed average adjustment in gross income for all farms in the United States is the

same under both methods, assuming (1) equal rates of returns for both the type of farm approach used in the Iowa State University study and the aggregative approach, and, (2) type of farm cost data are expanded to cover all types of farms in all regions. This is demonstrated in Appendix B of this article.

Utilizing the same data, a type-of-farm approach was also explored in this study.

The results of the computations are shown in table 5. For these calculations, the same rates of returns were assumed for operator and family labor and for invested capital as were used in the computations using aggregative data. In addition, normalized yields and abandonment were assumed. As can be seen in table 5, this approach reveals not only wide disparities between types of farms, but also those existing within given types, in the adjustments in gross income necessary to yield parity returns to such farms.

For cotton farms, for example, the computed necessary increases range from 85 percent for cotton farms in the Southern Piedmont region to negative increases in the irrigated High Plains region in Texas and the San Joaquin Valley of California. The negative figures indicate, of course, that incomes for these types were actually above parity returns income in 1961, assuming the rates of returns used for computations. There are wide disparities among other types, which are also shown in table 5.

Further examination of table 5 also reveals that, in general, the computed increases required in gross incomes to achieve parity of returns for the 37 farm types are negatively correlated with average total investment or productive assets. Figure 1 suggests that for farms with an average total investment above $75,000, required income adjustments would generally be much smaller than for those with smaller total investments. This is strikingly shown in figure 1. This relationship, of course, is not to be interpreted as simply meaning that all a farmer needs to do to improve his income position is to increase his investment. However, it does suggest that increased efficiency is associated with an increase in total investment up to a given point. This is also generally confirmed by the data shown by the aggregative major class of farm computations of table 3.

For some types of farms, however, figure 1 and table 5 show that even with relatively large investment, incomes in 1961 would have required substantial upward adjustments to achieve the parity of returns standard. This suggests that for certain types of producers differential adjustments in incomes or prices, or supply management measures might be appropriate to correct existing wide disparities in the income of the various types of commercial farms and to achieve desirable adjustments in supplies.

In any event, we should emphasize that the computed parity of income standard need not be applied rigidly or mechanically to all commodities. Rather, when supplementary studies indicate that adjustments from the overall changes indicated by the computed standard are desirable, such adjustments can be made and programs to eliminate disparities can be tailored to the needs of such producers.

Appendix A

Adequacy of Available Data for Measuring Parity

Numerous problems of practicability of measurement are encountered in any investigation of income parity in terms of parity returns to resources employed, in addition to questions of the segment of agriculture for which income parity is to be sought and of what is meant by parity of returns to resources employed in agriculture.

The present study employed the aggregative approach to measuring the necessary adjustments in gross farm income to yield parity of returns in the conceptual framework described earlier.

Under the aggregative approach, the computed percentage change for any given year in gross income necessary to achieve parity of returns can be applied to all commodities and all farms of all types, regional differences being determined pretty much as they are under the present unit of purchasing power determinations of parity prices. As we have mentioned earlier, this overall application would fix relationships among agricultural prices at levels determined in large part by market forces and existing programs designed to maintain prices of supported commodities at levels determined to be a certain percentage of parity under the old concept. Basing programs on this approach, therefore, in general would result in

TABLE 5.—*Estimated increases in gross income necessary to achieve parity income on representative commercial farms, 1961* [1]

Type of farm	Total investment	Total labor	Operator and family labor	Necessary increase in gross income with—
				Operator and family at factory workers' rates and hired labor at prospective minimum wage rate
	Dollars	*Hours*	*Hours*	*Percent*
Cotton farms:				
1. Southern Piedmont	26, 300	4, 872	2, 490	84. 7
Mississippi Delta:				
2. Small	13, 840	3, 440	2, 390	73. 5
3. Large-scale	214, 440	33, 535	3, 200	15. 0
4. Black Prairie, Tex	49, 630	3, 116	2, 314	38. 9
High Plains, Tex:				
5. Nonirrigated	60, 750	3, 092	2, 180	21. 2
6. Irrigated	117, 310	7, 685	2, 600	−5. 5
San Joaquin Valley, Calif.:				
7. Cotton-general (medium-sized)	275, 530	10, 010	2, 600	−3. 2
Cotton-general (large)	944, 860	30, 350	2, 600	−8. 4
8. Cotton-specialty	278, 360	12, 735	2, 600	10. 5
Peanut-cotton farms:				
9. Southern Coastal Plains	17, 180	4, 002	2, 980	49. 6
Winter wheat farms:				
Southern Plains:				
10. Wheat	96, 310	2, 960	2, 610	23. 4
11. Wheat-grain sorghum	89, 440	3, 030	2, 770	25. 8
Pacific Northwest:				
12. Wheat-pea	175, 280	3, 490	2, 750	9. 1
13. Wheat-fallow	148, 280	3, 670	3, 020	11. 5
Spring wheat farms:				
Northern Plains:				
14. Wheat-small grain-livestock	52, 110	2, 080	1, 640	13. 8
15. Wheat-corn-livestock	52, 870	3, 890	3, 700	55. 0
16. Wheat-roughage-livestock	49, 070	2, 730	2, 530	59. 0
Dairy farms:				
17. Central Northeast	41, 500	4, 440	3, 620	47. 4
Eastern Wisconsin:				
18. Grade A	62, 350	4, 460	4, 000	38. 5
19. Grade B	41, 170	3, 670	3, 580	79. 8
20. Western Wisconsin, Grade B	32, 860	4, 190	3, 900	73. 1
21. Dairy-hog farms: Southeastern Minnesota	49, 860	4, 060	3, 760	70. 2
Corn Belt farms:				
22. Hog-dairy	56, 720	4, 260	3, 830	48. 7
23. Hog fattening-beef raising	51, 500	3, 530	3, 290	72. 2
24. Hog-beef fattening	86, 770	4, 200	3, 650	22. 5
25. Cash grain	105, 940	3, 130	2, 820	25. 0
Poultry farms:				
26. New Jersey (egg producing)	44, 740	5, 250	4, 350	29. 7
Cattle ranches:				
27. Northern Plains	83, 890	3, 650	3, 360	48. 5
28. Intermountain region	86, 080	5, 020	4, 000	26. 6
29. Southwest	160, 700	3, 590	2, 350	33. 2
Sheep ranches:				
30. Northern Plains	96, 740	7, 190	4, 020	41. 7
31. Southwest	205, 200	6, 100	2, 550	41. 7
Tobacco farms:				
North Carolina Coastal Plain:				
32. Tobacco-cotton	25, 970	5, 467	2, 370	43. 7
33. Tobacco-cotton (large)	44, 880	8, 693	2, 530	42. 1
34. Tobacco (small)	12, 940	3, 056	2, 688	49. 9
Kentucky Bluegrass:				
35. Tobacco-livestock, inner area	100, 170	4, 680	2, 810	29. 5
36. Tobacco-dairy, intermediate area	22, 130	3, 510	3, 330	106. 1
37. Tobacco-dairy, outer area	41, 250	4, 690	4, 060	59. 7

[1] Returns are estimated at 1959 prices and cost rates with 1959 production adjusted for normal yield and abandonment. Returns to capital are estimated at 5.0 percent. Non-farm labor rates are estimated at the regional representative rate for manufacturing industries (U.S. average of $2.32 per hour). The farm wage rates are what was actually paid in each region. Prospective minimum wages are $1.25 per hour.

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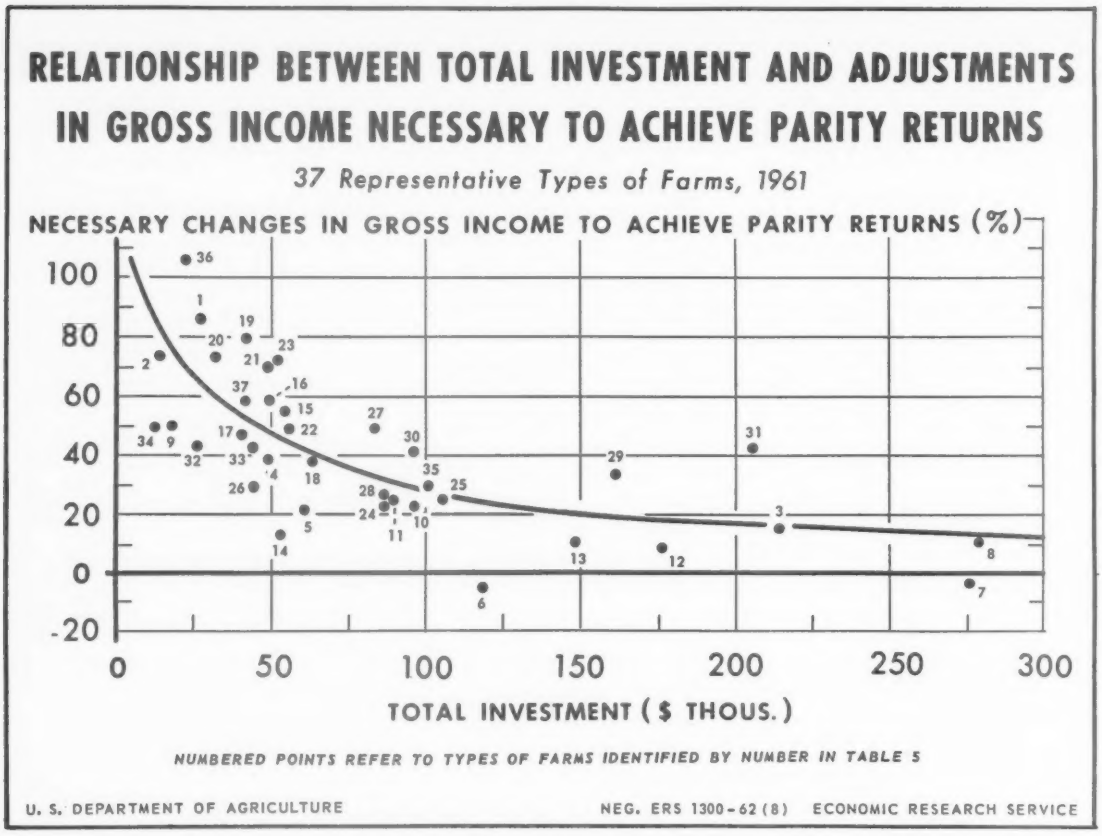

FIGURE 1.—Relationship between total investment and adjustments in gross income necessary to achieve parity returns, 37 representative types of farms, U.S., 1961

the least disruption of existing relationships as between prices of agricultural commodities.

The measurement on the aggregative basis illustrated in table 3 has incorporated in it some rather rough estimates of major class distributions of gross farm income, expenses, net income, labor employed, and capital resources. On the other hand, data on unit rates of returns such as the interest rates on mortgage debt and the hourly wage rates of manufacturing employees are readily available. For the computation of resources applied in agriculture the principal improvement required in the estimates would be in the determination of the distribution of total man-hour equivalents of labor applied and capital resources applied between those farms above and below the point of segmentation. In other words, if farms above $5,000 in sales are to be covered in the concept and measurement, then present aggregative estimates of labor resources applied and capital assets in agriculture must be divided between these two groups of farms. As of now, fairly reasonable estimates can be made by use of existing series, but more refined calculations of the distribution of cash receipts, expenditures and capital resources applied by major economic class groups would depend on the gathering of such information by means of periodic surveys.

Appendix B

Reconciliation of Iowa State Method of Determining Parity Returns and Prices With That Used in This Study

Aside from the problem of determining the unit return rates to be applied to agricultural resources

used, the type of farm approach such as that used by Iowa State may be reconciled in its mechanics and scope with the aggregative approach used in the ERS study.

In the Iowa State study derivation of parity returns prices for specific commodities, such as wheat, corn, dairy products and so forth, type of farm cost data are first combined with imputed parity returns for labor, land, and capital to arrive at a parity gross income measure for certain types of farms within a geographic area. The parity gross income measure is then (1) converted to a ratio relationship to an average of "normal production gross income" for such farms based on some estimate of normal production of specific commodities and average prices of such commodities for the preceding ten years and (2) applied to the preceding ten-year average of actual prices for a specific major commodity produced by that type of farm in that area to yield dollars and cents estimates of parity returns prices for the major commodity.

Parity returns prices for other commodities produced in the area are computed in terms of major commodity equivalents on the basis of the preceding ten-year average relationship of prices of all the various commodities to the major commodity produced by such types of farms.

The Iowa State Study thus uses type-of-farm cost data to arrive at a "representative" measure of aggregative parity gross income and average normal production gross income. These are then applied to an average of actual "market" prices for a major commodity to derive parity returns prices.

For each region, the product of (1) the ratio of parity gross income to the average of normal production gross income for the preceding ten years and (2) the preceding ten-year average price of a major commodity or its equivalent forces proportionate adjustments in prices for all commodities produced by such farms in that region. This, in effect, is the same as measuring aggregative income gaps for a region by using type-of-farm cost data as representative of the cost and income experience of all farms in that region and applying the indicated percentage adjustment as reflected by the "income gap" to a ten-year average price of each commodity produced by such farms in the region.

Income parity prices arrived at in this way for each region producing the same commodity are then combined by use of a simple average of prices of each of the rather small producing regions to derive a U.S. average for all such regions.

Essentially, then, there is no real difference between the general approaches used in this study and the Iowa State study, except of course for the estimation and application of unit rates of return to capital and labor and the comparison of parity gross income to an average normal production gross income for the preceding ten years. As a matter of fact, the Iowa State approach measures average income gaps or parity returns indicators, and average parity prices by means of simple averages.

Estimated income gaps shown in table 3, as developed in the Economic Research Service study, compare parity returns income with actual yield income for the preceding year. If, instead of the actual yield income for the preceding year, an average of normal production gross income for the preceding ten years were used, the parity returns indicators, in concept, would be generally the same as was used by the Iowa State group. And if the resulting percentage were then applied proportionately to the preceding ten-year average price for each agricultural commodity produced in the U.S., a system of parity returns prices for the U.S. would be determined similar to those developed by the Iowa State University study. But the system of U.S. average parity returns prices for the various commodities derived by the use of the aggregative method in this study is *a system of weighted averages of regional prices for each commodity, as computed by the Iowa State method, with the proportions of normal production gross income in each region to the total normal production gross income in the U.S. used as weights.*

What follows is an algebraic demonstration of the essential similarity of both methods.

For simplicity, and without loss of generality, let us assume that (1) agriculture consists of three types of farms, each located in a different region and; (2) each type of farm produces the same three commodities. Further, let us assume that four periods are involved—the current period, and three preceding periods. We shall denote the commodity produced by the subscript "i", the type of farm by the subscript "j" and the year by the

superscript "k", where the values of "i" and "j" run from 1 to 3 and of "k" from 1 to 4.

Now let us define:

O^k_{ij} as the output of the ith commodity on the jth farm in the kth period;

P^k_{ij} as the average price received for the ith commodity on the jth farm in the kth period;

I^k_{ij} as the input of the ith commodity, service or factor on the jth farm in the kth period; and

p^k_{ij} as the average price paid or imputed to the ith input on the jth farm in the kth period.

For each type of farm, total gross receipts from all commodities during the kth period will then be equal to

$$\sum_{i=1}^{3} P^k_{ij} O^k_{ij}$$

For all farms combined in the kth period, gross receipts is given by:

$$\sum_{j=1}^{3}\sum_{i=1}^{3} P^k_{ij} O^k_{ij}$$

Similarly for the total value of inputs, including those imputed at parity returns rates to labor and capital for each type of farm we have:

$$\sum_{i=1}^{3} I^k_{ij}\, p^k_{ij}$$

This is the parity returns income for the type of farm for the kth year.

And for all farms combined we have:

$$\sum_{i=1}^{3}\sum_{i=1}^{3} I^k_{ij}\, p^k_{ij}$$

This is parity returns income for all types of farms for the kth year.

Now the Iowa State formula for computing parity returns prices for a particular commodity in a given region or for a type of farm is given by:

$$(1) \qquad \overline{P}^4_{ij} = \left(\frac{\sum_{k=1}^{3} P^k_{ij}}{3}\right)\left(\frac{\sum_{i=1}^{3} I^4_{ij}\, p^4_{ij}}{\frac{\sum_{k=1}^{3}\sum_{i=1}^{3} P^k_{ij} O^k_{ij}}{3}}\right)$$

To simplify this, let us denote the second factor in parentheses on the right hand side by denoting it as:

$$\frac{\overline{I}_j}{\overline{O}_j}, \text{ where}$$

$\overline{I}_j$ represents the total value of inputs and imputed returns to all farms of type j in the current or 4th period (or parity returns income); and $\overline{O}_j$ is the average of total normalized gross receipts for all farms of this type during the preceding three years or periods. Also let $\overline{P}^4_{ij}$ represent the parity returns income price for the ith commodity in the jth region.

Then (1) may be written as:

$$\overline{P}^4_{ij} = \overline{P}_{ij}\frac{\overline{I}_j}{\overline{O}_j}$$

The average parity returns price for the U.S. as a whole is thus given by:

$$(2) \qquad \sum_{j=1}^{3} \overline{P}^4_{ij} = \frac{\overline{P}_{ij}\sum_{j=1}^{3} \overline{I}_j}{\sum_{j=1}^{3} \overline{O}_j}$$

The $\overline{P}_{ij}$'s for each region are all equal in the Iowa State framework since these are all computed for each commodity in terms of primary producing area equivalents.

Now (2) can be written at length as:

$$(3) \qquad \sum_{j=1}^{3} \overline{P}^4_{ij} = \overline{P}_{i1}\frac{\overline{I}_1}{\overline{O}_1} + \overline{P}_{i2}\frac{\overline{I}_2}{\overline{O}_2} + \overline{P}_{i3}\frac{\overline{I}_3}{\overline{O}_3}$$

This represents the simple average of all parity returns prices for the different regions, or a U.S. simple average price.

However, if instead of a simple average for all regions, we were to compute a weighted average, where weights are equal to the ratios of total gross income in each region to the grand total for the U.S., we would then obtain:

$$\sum_{j=1}^{3} W_j \overline{P}^4_{ij} = \overline{P}_{i1}\frac{\overline{I}_1}{\overline{O}_1}\left(\frac{\overline{O}_1}{\overline{O}_1+\overline{O}_2+\overline{O}_3}\right) + \overline{P}_{i2}\frac{\overline{I}_2}{\overline{O}_2}\left(\frac{\overline{O}_2}{\overline{O}_1+\overline{O}_2+\overline{O}_3}\right) + \overline{P}_{i3}\frac{\overline{I}_3}{\overline{O}_3}\left(\frac{\overline{O}_3}{\overline{O}_1+\overline{O}_2+\overline{O}_3}\right)$$

$$= \overline{P}_{i1}\left[\frac{\overline{I}_1}{\overline{O}_1+\overline{O}_2+\overline{O}_3} + \frac{\overline{I}_2}{\overline{O}_1+\overline{O}_2+\overline{O}_3} + \frac{\overline{I}_3}{\overline{O}_1+\overline{O}_2+\overline{O}_3}\right]$$

(4)

Since $\overline{P}_{i1}=\overline{P}_{i2}=\overline{P}_{i3}$ in the Iowa State framework.

This simplifies to:

$$\sum_{j=1}^{3} W_j \overline{P}^{A}_{ij}=\overline{P}_{i1}\left(\frac{\overline{I}_1+\overline{I}_2+\overline{I}_3}{\overline{O}_1+\overline{O}_2+\overline{O}_3}\right)$$

The factor $\frac{\overline{I}_1+\overline{I}_2+\overline{I}_3}{\overline{O}_1+\overline{O}_2+\overline{O}_3}$ is thus seen to be the ratio of aggregative parity returns income to the average of aggregative actual income for the three preceding years for all 3 types of farms. And the weighted average parity returns price for the ith commodity is seen to be simply the product of this ratio and the average price of the ith commodity for the preceding three years.

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An Approach to Production Response

By Richard H. Day

Nonnormative models of aggregative agricultural production are frequently based on the correlation of output variables with prices (usually lagged) and outputs lagged over time. "Structural" models of this kind relate these correlations indirectly to the behavioral and technical structure that gives rise to them. The main purpose of this paper is to show how a knowledge of structure may be used to construct a model that simulates the aggregate actions of producers. The resulting model is useful in explaining past production patterns, in predicting future changes, and in assessing effects of alternative policies. A further purpose is to provide a theoretical understanding of the many forces that determine production through time. The author develops certain hypotheses of long standing in economic theory in an explicitly empirical and institutional context. He notes the following three as among the most important: (1) The neoclassical concept that firms maximize something when they determine output; (2) the Marshallian relation of investment to past profits and quasirents; and (3) the Schumpeterian relation between investment and technological change. To these he adds the use of behavioral constraints that arise from uncertainty and lack of knowledge. Some of the observations and principles described in the paper are empirical rediscoveries of certain theoretical principles cogently set forth by Schumpeter (*12*).[1] The method is also closely related at some points to the work of Leontief (*6, 7, 8*), Wood (*14*), Henderson (*5*), Georgescu-Roegen (*3*), Marshall (*9*), Walras (*13*), and Nerlove (*10*).

The empirical research out of which the new approach took form owes much to staff members of the Farm Economics Division, Economic Research Service. Thanks are due the National Cotton Council for support in the preparation of this paper.

PRODUCTION RESPONSE is the term that research workers use to describe the study of forces that have determined past production patterns and may govern future ones. As it includes forecasting the repercussion on production patterns of actual or potential policy actions, production response belongs to the descriptive and predictive branch rather than to the normative branch of economic science. The term "production response" has been used for many years in this broad context to distinguish its content from that of more narrowly oriented studies of supply response to price.

Recent articles by students of production response have emphasized the complex nature of production in agriculture (*11*). Many methods have been used, with varying degrees of success, to describe and analyze production response phenomena (*4, 6, 7*). In a forthcoming book based on my dissertation completed last year, I describe a new approach to this problem.[2] This approach uses a dynamic mathematical system called "recursive programming" to describe and interpret the production patterns of an agricultural region over time. Briefly stated, recursive programming consists of a sequential chain of recurring linear programming problems in which the structural components of each year's problem depend on the solution for the preceding year. It involves optimizing over a limited time horizon on the basis of knowledge from the experience of the past with regeneration and reformulation as each year's experience is accumulated. The model enables a wide variety of forces that are related to production changes to be analyzed together.

Observations and hypotheses about economic behavior from which the model grew are given in this article. It describes how the model accounts for some of the major economic forces related to changes in agricultural production. Many of these observations and hypotheses have played a major role in general economic theory and in discussions of agricultural economics. In

[1] Italic numbers in parentheses refer to Literature Cited, page 148.

[2] Day, R. H., Recursive Programming and Production Response. 1961. On file Harvard University, Cambridge. The book, which is based on the dissertation, is to be published in the series, "Contributions to Economic Analysis," North-Holland Publishing Company, Amsterdam —C, The Netherlands. Also described in (*4*) pp. 108–125.

this approach they are empirically verified by relating them to what actually occurs at a regional level as a result of farm producers' real economic decisions [3] and they are given formal mathematical expression so as to generalize our theoretical understanding of the economics of production.

The discussion is divided into four major sections. The first deals with the optimizing principle; the second describes certain aspects of the farmer's decision environment; the third describes how investment in variable, quasifixed and fixed production inputs appears to operate in agriculture, and how technological change occurs; and the fourth describes nonmathematically how a recursive programming model is based on the observation presented in the preceding sections. A publication describing the empirical results of this model, now in preparation, will include a discussion of techniques used in estimating the various structural parameters in the model.[4] Attention here is confined to its methodological properties.

The Optimizing Principle

Let us begin with what is perhaps the most novel—and controversial—aspect of the method, the application of the optimizing principle to the description of actual economic behavior. Statistical methods for estimating supply relationships have typically disguised the role of this principle, and it has come to occupy an ambiguous position in both empirical and theoretical understanding.

Do Farmers Maximize?

Inadequate knowledge of technical possibilities and of the complex forces affecting prices and costs of production surely make true optimal action as difficult to determine for farmers as for economists. But to explain actual planning behavior, it is virtually impossible to dispense with profit maximizing. For example, a small southern renter with a 15-acre operation and a 3-acre cotton allotment, who refuses to abandon farming even in the face of a substandard income, attempts to allocate his remaining acreage among such alternative crops as he believes to be economically best. To be sure he does this with little certainty that his expectations will be realized; but do it he must, as best he can.

The more one becomes acquainted with farmers of varying types and varying success in operation, the more one is impressed with the validity of the optimizing principle. It is not exercised as a tool of ideal optimal choice. Rather, it seems to be a homely guide to choosing among limited alternatives in an environment that is only partly the result of a farmer's own volition.

This empirical hypothesis that farmers attempt to plan as best they can is the foundation for explicitly using the optimizing principle in nonnormative analysis.[5]

A Theoretical Imperative?

Spatial equilibrium or regional competition models of production are examples of explicit uses of the optimizing principle (*4*, pp. 203–227; *2*). In their current forms, however, they are both static and normative in nature. Both have limitations for the problem under consideration here but in application both can be alleviated to some extent. Thus, the results of such models can be viewed as long-run equilibria and may be used to project the direction in which production patterns are likely to move. Therefore, this kind of comparative static analysis is a useful tool for nonnormative analysis if the empirical hypothesis of optimizing behavior is accepted.

Statistical models of supply, on the other hand, do not describe maximizing behavior directly. The results of these models can be evaluated *statistically* in a relatively straightforward way, an advantage not currently shared by programming models of regional competition. The *economic* evaluation of such results poses a more difficult problem. It is here that practitioners of the statistical arts are typically vague. Some argue that the statistical method relieves their studies of certain aggregation problems (a subject we shall re-

[3] Some of these hypotheses have been regarded as valid for normative or prescriptive analysis and have been utilized for this purpose (*4*, pp. 203–227) (see Day, footnote 2). Our application is to nonnormative or descriptive and predictive economics.

[4] For preliminary empirical results, estimation techniques, and mathematical analysis, see Day, footnote 2.

[5] This hypothesis has been tested both formally and informally, as have those described later. It was tested formally in detailed discussions about planning procedures with a randomly selected group of farmers in the Mississippi Delta. I rely also upon informal conversations with Iowa farmers over a period of many years. Both sources support the validity of the optimizing principle as it is described in the paragraphs preceding, and in those that follow.

turn to below) and that "aggregative behavior" differs, after all, from the behavior of individual firms (*11*). But when it comes to economic evaluation, they often rely upon the optimizing principle. Thus, negative price elasticities of supply are usually regarded as unmeaningful, positive ones as valid. This conclusion rests on the idea that it does not make sense for producers to expand production of a commodity when its expected price is falling. That is, such an inverse supply response does not conform to our idea of what farmers need to do in order to maximize their incomes.[6]

A reference to the optimizing principle must be made in order to evaluate the economic meaningfulness of statistically fitted supply models. Thus its explicit application to predictive and descriptive analysis is not as novel as might first appear.

Models that explicitly employ this principle are usually called "programming" or "mathematical programming" models. They include linear, nonlinear, stochastic, and dynamic programming models, and also the method described here, recursive programming. Applied to agricultural production response, recursive programming can express the hypothesis that farmers make their production plans in order to maximize their incomes. But they do this with due regard for the uncertain nature of output, prices, production costs, and yields of their various enterprises. This "due regard" becomes the heart of the problem once the optimizing principle is accepted—that is, the question is not whether or not farmers optimize, but rather how the circumstances that condition their optimizing activity can best be described.

Although strong empirical and theoretical arguments favor the explicit use of the optimizing principle, one can be less emphatic in specifying just what is maximized. Current applications of recursive programming use expected gross profits, that is, expected gross income less current production expenses, including the opportunity cost of operator labor. Since any income or profit variable is closely related to this "gross profit," it is useful as a first approximation. Initial results using this variable suggest that it is substantially valid.

[6] This is true in a static sense only. It can be shown by means of recursive programming theory (*4*, pp. 108–125) that such inverse supply relations can, and frequently do, logically result from the optimizing principle placed in a dynamic context. The latter result is described below.

But it would be advisable to test other maximizing variables. Possibilities that seem particularly relevant would be the total discounted gross profit over several time periods, an income measure from which the opportunity cost of nonwage labor has not been deducted, or a measure from which allowances for depreciation and other "fixed" costs have been deducted.

It would follow from the pure economic theory of the agricultural firm-household that a utility function should be maximized in which household as well as production activities are included. But the overwhelming difficulties of applying this approach for empirical analysis at an aggregative level appear—at least at present—to preclude its consideration.

Planning Over Time

Production plans for a given production period depend upon both the past and the future. Past decisions result in the current stock of resources and assets that form the basis on which current plans for the future are contingent. On the other hand, current plans also include anticipation of actions to be taken in future periods. The number of future periods for which the producer accounts in his current plans is commonly called the *time horizon* of the production plan. Because of the extreme uncertainties in agriculture, this horizon is typically short, and not owing to myopia, but rather to the rapidly decreasing certainty of anticipated actions being realized, as plans are extended further into the future.

The theory of planning over time was introduced into the history of economic theory comparatively recently, but it has undergone an extensive and highly esoteric development in dynamic programming literature. The application of this theory to the aggregative empirical problem under consideration here is beset with difficulties. This is particularly so in the choice of a time horizon and the weighting of anticipated decision criteria at the regional level, to represent accurately the time horizons and weights that are formulated at the firm level. Further research may show, however, that it is useful to attack these difficulties and to account explicitly for time horizons and their accompanying uncertainty discounts.

In either case, the important distinction between planning over a fixed time horizon (dynamic programming) and the sequential generation of production plans (recursive programming) should be noted. The former determines plans that are to be executed in the current period, and anticipates plans that are *currently* designed for future execution. The realities of economic life, however, force changes in even the best laid plans. So, with the passage of time, future plans are revised in light of current and temporary conditions. A model that reflects that actual course of economic planning as it affects actual production decisions must provide for the continual regeneration of the planning process. Recursive programming models do this, even when they include planning over time, and consequently must be distinguished from dynamic programming models.[7]

The Decision Milieu

We must now turn to consideration of the environmental forces that influence maximizing behavior. If farmers' activities are to be described adequately, and more important, if the aggregate results of their decisions are to be explained and predicted with useful accuracy, it is necessary to account for the salient features of their economic environment. This section discusses three important aspects of the farmer's decision milieu: (1) Market structure, (2) uncertainty, and (3) management leadership.

Market Structure and Aggregation

Agriculture is one of the very few of the industrial and commercial sectors in the United States that resemble the market structure assumed by classical theory of perfect competition. For most major farm commodities, large numbers of producers grow and market substantially homogeneous goods. None has the power to influence appreciably the market prices for outputs. Moreover, producers rarely exercise any real control over the prices of productive inputs. Indeed, it is largely these phenomena of an atomistic industry that have enabled the econometrician to apply his methods to agriculture with considerable success; and it greatly enhances the explicit application of the optimizing principle for explaining actual behavior.

Because farmers cannot influence prices through independent action, they plan output given certain price expectations. Price is a predetermined variable in the decision process. The many theorectical and empirical problems of oligopolistic and oligopsonistic behavior are not confronted. The output decisions of each producer can more hopefully be aggregated into a single regional decision problem.

An aggregate composed of farming units with identical linear technical possibilities and with price expectations and supplies of quasi-fixed and fixed factors that differ only by factors of proportionality could be exactly described by a single regional decision model.[8] This concept becomes the prototype for the explicit application of the optimizing principle. Recursive programming models must be applied to geographical or type-of-farm aggregates that are homogeneous enough to avoid serious distortion. A hypothesis that causes a considerable degree of effective homogeneity among farmers in a given area is described below. Before turning to its consideration, however, let us first examine some aspects of market structure that lead to "imperfections" in atomistic competition.[9]

Uncertainty and Imperfect Knowledge

As suggested above, farmers are well aware that their incomes seldom turn out to be those planned, that price expectations are seldom realized. Their best expectation of output prices is uncertain. Contrary to this fact, the neoclassical analysts of competition assumed something called "perfect knowledge," an assumption that even though demand schedules were not known, the equilibrium prices that *would be* obtained were known exactly. This theoretical acrobatic was

[7] How both planning over time and the sequential generation of planning can be treated together by means of recursive programming has been shown elsewhere (*4*, pp. 108–125; and *6*. See also Day, footnote 2).

[8] By identical linear technical possibilities we mean that all farmers' production structures can be presented by identical process analyses or linear programming models. We mean by a factor of proportionality that all farmers use the same quasi-fixed factors and that the stocks of these factors which a given farmer possesses vary from those of another farmer by some percentage constant for all factors.

[9] An atomistic market is one in which all members produce a homogeneous product, and in which none can influence prices in his own favor by his own production and marketing decisions. Perfect competition implies much more; cf. Chamberlin (*1* p. 6).

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needed because the neoclassical economists had no well-developed tools of dynamic analysis. Such an assumption was required to obtain equilibrium solutions to static market models. Thus the mathematics of perfect competition lack the requirements to describe actual planning behavior. Applications of conventional linear programming to long-run normative analysis must logically rely on a similar assumption that long-run equilibrium prices are known with perfect certainty. If this were not so, their results could hardly be regarded as long-run normative solutions.

Recursive programming gives the optimizing principle a different context by adopting the hypothesis that farmers' plans are made on the basis of expectations derived from past experience, which at best will only be partially fulfilled, and further, that these plans are influenced by *imperfect* knowledge of demand.[10]

The first part of this hypothesis is common to nearly all empirical expectation models that use past prices discounted in some way for uncertainty. In a linear programming model with a finite number of alternatives, predictions of aggregative behavior could be grossly unstable if only this part of the hypothesis were included. In some agricultural regions certain rather specialized alternatives, even at *discounted prices*, are relatively more profitable than others, and usually by substantial margins. Consequently, unless explicit upper and lower bounds are set to reflect uncertainty, a programming model will predict much greater specialization for a given year than is commonly observed in many areas of the country. These bounds have the effect of limiting the concentration of the most profitable crop on a farm or in a region.

Intense regional specialization in one year, however, would cause a fall in prices received (in the absence of supports) through its effect on aggregate production. The most profitable crop for the next year might now appear to differ from the most profitable one for the first year, and intense specialization might then occur in a different crop. In short, such a model would predict violent yearly oscillations in production patterns. Since agricultural production as measured by acreage does not oscillate violently from year to year, something in addition to price discounting must be included in a production-response model of the linear programming genre. As upper and lower bounds in a linear model will limit the production changes implied by a given set of net returns, we regard the formation of such bounds or constraints as a part of the decision process. How or what is the information by which such contraints are formed constitutes the problem.[11] It is in the imperfect knowledge of demand that we find the required ingredient.

Informal and formal discussions with Iowa farmers and with sharecroppers, small farmers, and large plantation operators in Mississippi suggest that farmers everywhere realize that output and price are related and that an aggregate shift in production from one commodity to another or in the general level of output has, in the absence of price supports, a definite and inverse relation to prices. A farmer knows also that what is good for him is commonly good for many other farmers in the same producing region. Therefore, he knows that the intensity of a relatively profitable alternative may be increased by many farmers and that the net result may be to damage his profit position if he specializes too extensively. This *imperfect* knowledge of the effect of aggregative supplies on price leads to restraint in changing output patterns in response to relative discounted price expectations. Such restraints can be explicitly provided for in current recursive programming models of production by means of dynamic upper and lower bounds. These bounds are called flexibility constraints. They are described below.

Management Leadership and Innovation

A third important characteristic of the decision process in agriculture that has particular relevance for the direct application of the optimizing principle to nonnormative analysis is the role played by the efficient producers and innovators of a given

[10] For many years, statistical supply models have accounted for price uncertainty by using various expectation models. Cf. Nerlove (*10*). The attempt here is to introduce this approach in an optimizing model of production. Various models of stochastic programming have also attempted to account for uncertainty, as in a different context have various models of portfolio selection. For the most part, these have been normative in nature.

[11] Henderson (*5*) was the first to recognize the importance of such restraints. He used them as "catchall" bounds to describe the constraining influence of uncertainty, lack of knowledge, and quasi-fixed factors, whereas we treat these forces separately and in an explicitly dynamic context.

area. Most counties in any important agricultural region contain some farms that are significantly more efficient and prosperous than others, partly because of superior natural resources, but largely owing to superior management. These efficiently operated farms tend to become planning models for those producers who are only modestly gifted in the art of farm management.

The managers of these efficient operations are frequently in close touch with agricultural experiment stations and other sources of expert knowedge of advanced farming techniques. Ordinarily, they are not the first to apply a new production technique and are thus to be distinguished from innovators. But they are commonly among the first to adopt a successful innovation and, conversely, they seldom adopt an unsuccessful one. Most producers are slower to see the economic advantage of a given innovation. They are more cautious in the application of a new technique and they require more time to become convinced of its economic advantage. The same observation can be made of the process of altering livestock and cropping patterns.

For these reasons, response to changing economic conditions is commonly distributed through time. This is true of the response to both changing technical possibilities (innovations) and other changing sources of profits. The proper application of the optimizing principle must therefore be made in the context of this dynamic adjustment process.

The systematic search for optimum production plans seems to be an activity confined to a relatively small number of producers, and the resulting decisions guide the great body of farmers (in the way just described) in their own decision-making activities. The important implication of these observations is that the aggregation problem should be greatly reduced; in a given region, economic variables should behave as if they were the result of a much more homogeneous group of producers than is actually the case. Empirical results obtained appear to confirm the validity of this hypothesis.

The Dynamics of Input Utilization

An observation that must occur to any student familiar with the broad spectrum of econometric production investigations, is that the production economists seem to have been concerned almost exclusively with details of structure and not with aggregative implications. The macroeconomists, however, have too frequently confined their research to the behavior of aggregative variables without examining the structure by which the movements of such variables are conditioned. It is true, they have attempted to derive structure indirectly by use of "structural" statistical models. But efforts in this direction have not supplanted the need for direct exploration of the dynamic structural nature of the farm economy.

The awareness of this impasse undoubtedly explains the increasing effort in recent years to dig beneath the surface of aggregative variables and to explore the basic input-output relationships and their relationship to the movements of aggregate production data over time. Technical description of input-output relationships has reached a high state of development and we have more in the way of meaningful hypotheses here than elsewhere. Budgeting analyses, statistical production function analyses, and more recently input-output and process analyses now provide a rich source for analyzing the ultimate conditions upon which rest the dynamics of production.

Therefore, I shall emphasize the relationships between the *technical* structure of production—as revealed through analyses of the kinds mentioned—and the dynamics of investment in the productive inputs themselves. For this purpose, it is convenient to follow the common classification of production inputs; inputs that are variable factors, such as labor services, fertilizer, and other materials normally used up in one production period, and inputs that are quasifixed and fixed factors not used up in one production period. When farmers depend to some degree upon the market for money capital, these two categories correspond roughly to the two major types of money loans connected with production, production loans and investment loans.[12]

Variable Factors

The demands for variable inputs, such as fertilizer, labor, and other production materials, are related to the technical structure of production and the prices of both outputs and inputs. The former determines the quantities of inputs required to produce various quantities of outputs. The latter

[12] Glenn Johnson, Earl Heady, Clifford Hildreth, and Marc Nerlove are among those who have attempted to recognize explicitly the role of quasifixed and fixed factors in agricultural production response.

determines the profits from alternative production plans. However, the actual demand for a given input or, in other words, the planned utilization of a given input, also depends upon the supplies that are expected to be available of *all* variable, quasi-fixed, and fixed inputs. This has been amply demonstrated by past responses of farmers to restrictions in the supply of land imposed by acreage controls. For example, the increased intensity of fertilizer use appears to have been accelerated by the effects of a declining supply of land available for production of controlled commodities. To explain the relationship of production to the corresponding use of variable factors, the economist must understand what limits the supply of productive inputs at any given time.

It has been argued that the supply of variable inputs does not affect production, that is, in the short-run—the "run" in which all plans are actually consummated—these inputs have an unlimited availability. Further, it is sometimes supposed that they have an unlimited availability at *existing prices*. But farmers are too well acquainted with their local factor markets to suppose that this is the case. They know from experience that at least some inputs are in restricted supply within the range of prices they can pay.

Just as they limit the production of profitable outputs because of known but uncertain relationships between aggregate supply and output prices, so they limit their demand for inputs because of correspondingly known but somewhat less certain interaction between input supplies and input prices. A Mississippi Delta farmer explained to me that he was investing in cottonpickers, even though at existing prices hand labor was cheaper, because he knew that the local supply of labor was falling and to induce labor from surrounding areas to pick his cotton he would undoubtedly need to pay an uneconomic price.

Demands for inputs are dampened by the effects of such considerations, or we might say the supplies of inputs expected at prices farmers are willing to pay are limited. To the extent that purchases of variable inputs are financed from production loans, this dampening takes the form of credit rationing. Farmers on the other hand are led to ration their demand for money capital, while local banks on the other hand are led to ration their supply of credit.

Migration of agricultural laborers to urban areas, particularly since World War II, has caused the supply of available labor services to decline. The constraining effect of this migration depends upon the rate of adoption of labor-saving technology. If the rate of adoption is sufficiently high, the supply of labor is in effect unlimited and no effective labor constraint arises. But labor may constrain output in periods of low investment in labor-saving technology. For our purposes, we need not commit ourselves to the inclusion of one effect or the other. Rather we attempt to include the supply of labor through time as a part of the dynamic structure of production and then derive the actual times and places and hypothetical conditions in which one or the other of the possible effects can be observed.

A third force leading to short-run constraint in the supply of a variable input arises in a period of rapid expansion in the demand for that input. Its production follows a growth process of its own. Available supplies of such a factor are limited by this process. This kind of input supply restraint is particularly evident in periods of technical innovation and adoption when the supply of laborers with certain skills is limited by the rate at which these skills can be disseminated or, for example, when the supply of a new type of fertilizer or insecticide is restricted by the rate at which capital formation takes place in the (possibly new) industry producing it.

I have mentioned three forces that may lead to restriction of variable input supplies in the short-run. One is the effective supply of a factor within a price range a farmer is willing and able to pay. The second is the absolute decline in physical capital from which production services as variable inputs can flow. The third, which is logically similar to the second, is the possibility that the rate of growth in supply of a variable input may be restricted because of the process by which the industry producing it expands. In connection with the last two points, we have discussed the relation of *physical* capital to the supply of variable inputs, but we have not yet discussed *money* capital, and we now turn our attention to this subject.

The process of investment cannot be ignored even in considering the short-run production plan of the firm. This is because a farmer must allocate any money capital he may acquire between

the purchase of variable and quasifixed and fixed inputs—that is, between short- and long-run investments. Here again some argue that this area may be ignored because the supply of money capital is practically unlimited. My conversations with farmers, however, have suggested that, even production loans are often hard to come by.

In one such conversation a person told me he had farmed during the immediate postwar period. He was denied further advances from the local bank after a single failure to repay the year's production loan. It would be desirable, therefore, to include in a production response model a dynamic variable describing available supplies of money capital. Such a variable would act as an upper bound, changing through time, on the total regional effective demand for money to invest in productive inputs. It would be related to such variables as past years' regional income and interest rates. Current recursive programming models do not in fact include such a relation, but the methodology can accommodate it. Further efforts should be made to remove this inadequacy.

Quasifixed and Fixed Factors

In a developed region the supply of land is limited and can be treated realistically as a fixed factor, but in an underdeveloped region investment in land need not be considered as differing essentially from investment in machinery and buildings and other less durable inputs. Even in a developed region, land can be regarded as a quasifixed factor. Erosion and nutrient leaching diminish its productivity, which can be maintained only through investment in various conservation improvements. This is analogous to depreciation on less durable inputs. Consequently, in what follows, we may restrict attention to quasifixed factors.[13]

Quasifixed factors (durable production inputs) are not entirely used up in the production period but yield a flow of services. The quantity of services flowing from a given machine is limited by the machine's capacity. The capacity of a quasifixed factor is particularly difficult to define or to measure. A given factor in many instances can be more or less intensively utilized, but often it is possible to define a rough measure that is useful for empirical investigation. The capacity of plowing services for a four-row tractor, for example, may be regarded as the number of acres it can plow under normal conditions in an average working day.

The demand for services of quasifixed factors, and consequently the demand and supply of quasifixed factors themselves, is governed essentially by the same forces as those which govern the demand and supply for variable factors. The amounts of their services required for various levels of output, together with prices, determine the demands for such inputs, and the three forces and money capital discussed in the preceding section operate in much the same way. However, the durability of these factors requires some additional consideration.

As quasifixed factors can yield services not only in the current production period but also in subsequent periods, decisions to invest in them must account not only for current but for anticipated future production plans. Since future prices (and Government-control policies) are even more uncertain than those for the imminent production period, the number of periods in the future that need to be accounted for is usually few. The problem of choosing a finite time horizon for economic analysis, even one of relatively short length that would adequately represent the effects at a regional level of farmer's individual decision processes, may be even more difficult than measuring the capacity of durable inputs. However, there is a second approach that has proved useful in current regional applications of recursive programming. It enables us to account for investment in quasifixed factors without explicitly accounting for a time horizon longer than a single time period.

Suppose a given process of production is particularly profitable, but that the capacity of a certain quasi-fixed factor whose services are required by the process is limited within a given region. For example, suppose harvesting soybeans with self-propelled combines is highly profitable but only a few are owned by farmers in the region. The maximum number of machines required to harvest the desired acreage of the crop will not be purchased immediately, partly for the reasons already indicated, but mainly because farmers do not want to have too large a stock of this capital good in succeeding years if soybean prices should

[13] Note also that in an agriculturally developed region, urban encroachment will force treatment of land not as a fixed, but as a quasifixed factor. Current models have not yet accounted for this phenomenon.

fall. If the process continues to be profitable, increasing numbers of machines will be purchased.

It has been observed empirically (*14*) that, in the face of continuing profitableness over a long period of time, the purchases of a given capital good will grow at something like a geometric rate over time. In agriculture this rate will depend upon the rapidity with which farmers can accustom themselves to the new machines, and to the growth process of the supplying industry. This may be called the *maximum potential growth principle*. It defines a maximum limit by which investment in quasifixed factors may be constrained in a given region. This maximum limit, as indicated, need not actually be attained. Actual investment in a particular input may fall below the rate regarded as possible under this principle, and frequently it will do so.

Other forces, such as a limited supply of complementary variable, quasi-fixed, and fixed factors, may constrain production. Consequently, at some time, or perhaps always, investment may fall below the potential rate. Thus, within the framework of these constraints, actual regional investment can be determined. As before, we do not commit ourselves to one or another of the possible effects of the limitation on the supply of quasifixed factors. Instead, we ask under what conditions they will or will not affect the output of a given commodity.

The optimizing principle applied at the regional level implies that the stocks of quasifixed factors predicted for the region can be distributed among farmers in an optimal manner. In many regions, this condition is brought about approximately by an active custom market for the services of quasifixed factors. To the extent that such markets do not bring about a free movement of such resources, the model will be biased.

Technological Change

Technological change can be conveniently broken into three components—invention, innovation, and diffusion or rate of adoption. The first of these three components is of crucial importance in the growth process, and it is particularly intractable to existing tools of economic analysis. But for the problem of aggregative production analysis, it need not be explicitly considered. Only in the hands of an innovator does an invention enter the production process. Consequently, treatment of technological change begins with the second component.

It is almost as difficult to predict innovations as inventions. This need not detain us, however, since the number of innovators in a given region is typically very small relative to total number of producers. For this reason, initial impact on production is small.[14] This aspect of the problem is described earlier in this paper.

To study the effects of technological change on production, we begin with a historical period in which a major innovation, such as use of the cottonpicker or production of a new commodity, is introduced, and regard it as a *fait accompli*. That is, we treat innovation as a condition of the production structure historically given. We now turn to consideration of the third component.

In a developed region (or one subject to rigid production controls) in which the total outputs of its several commodities are either stable or declining, the adoption of a new innovation may not cause an expansion of production. The effects of adoption operate primarily on the use of other techniques of production now obsolete. Substitution takes place between new and old techniques, the old being gradually abandoned and replaced with the new, typically at an accelerated rate over time.

When total production of some outputs is expanding, an innovation may not at first be observed to replace old techniques. If production is expanding faster than the rate of adoption of the new technique, even the old techniques will expand for a time until the rate of adoption of the former surpasses that of output growth when the same substitution effects as before will be observed. It is also possible that the entire expansion of output will occur via the new techniques and that the old methods will remain relatively unchanged for a time, or perhaps begin an immediate decline. The actual paths of these variables are determined by all forces acting on investment and production in the region.

In order to understand the relation of technological change to production, it is evident that the

[14] This is not to imply that the economics of innovation should not be studied. We can proceed with an analysis even though adequate models of innovation do not yet exist. The effects become increasingly important as diffusion takes place.

process of diffusion needs to be understood. The decision to invest in a machine not previously utilized, or to produce a commodity not previously cultivated, is governed by much the same forces as determine investment in available and quasifixed factors already commonly used throughout a region. Consequently, all those forces already discussed can be expected to operate in this sphere. Indeed, I shall take as the fundamental hypothesis about the process of technological change that it needs to be treated as an integral part of production and investment planning, and that the analysis of variable and quasifixed factors applies with equal validity to its analysis.

But innovations are characteristically new and unfamiliar, and this distinction between them and the older techniques leads to an additional force acting on investment and production that cannot be ignored. This force is the progress of technical know-how and confidence in the advantage of the innovation which must accompany its diffusion. Diffusion is limited by this progress, and unless it is accounted for explicitly, investment in new techniques is frequently and significantly overpredicted.

Confidence, familiarity, and knowledge are acquired more gradually by the great body of producers than by the innovators or rapid adopters, so that innovation is frequently observed to follow something resembling a geometric or compound interest growth curve—if its high profitableness continues. Furthermore, the rate of its growth appears to depend upon its newness. Thus a radically different innovation is likely to be adopted more slowly, all other things equal, than a relatively minor change in an already familiar technique. For example, the diffusion of the use of liquid nitrogen occurred at a vastly greater rate in many areas than the earlier diffusion of the use of solid nitrogen fertilizers.

As the magnitude of additional profits induced by adoption (marginal returns to investment) typically declines, and as diffusion continues, the availability of complementary factors may become limited, and uncertainty as to continued profitableness may grow. After diffusion has continued for a time, therefore, it may be expected to exhibit a declining rate. This explains the familiar S-shaped curve observed in many diffusion or rate of adoption studies.

The Method of Recursive Programming

How can these salient traits of production response be formalized and given empirical content? This leads to the construction of a recursive programming model for a particular economic area and thence to the mathematical and economic theory of recursive programming systems in general. Both aspects of this demonstration were developed elsewhere (*4*, pp. 108–125).[15] Here the discussion is limited to a description of how recursive programming simulates the economics of production as conceived in the preceding sections.

As in all econometric investigations, a particular model is a judicious compromise between the conceptual understanding of an economic process and the possibility of representing and testing this conceptual understanding with real data. It is one thing, therefore, to be satisfied with a model and another to be satisfied with the general theoretical system which the model represents. To distinguish these two aspects, the description of current models is followed by some further remarks on the pure theory of recursive programming. This will enable us to see how our understanding of production response may be formalized, even though current econometric models may not describe that understanding completely.

The Processes of Production

The technical production processes available in a region in a given year are represented by their respective input and output coefficients. These coefficients measure the yields expected per unit of the process and the physical costs in terms of quantities of variable factors used up and the services of quasifixed factors employed per unit of the process. The processes are defined for machine combinations of a given technological stage, by soil class, and by a number of discrete fertilizer intensities.

Thus, separate processes are defined for each machine—soil class—fertilizer level combination for each crop.[16] Each process is measured in terms of acres. Each output coefficient is measured in yield per acre in suitable units such as bushels, hundredweight, and so on. Each variable input coefficient is measured in per-acre requirements in

[15] See Day, footnote 2.

[16] The fact that a nonlinear relation exists between the yield of a crop and the quantity of fertilizer used leads to no difficulty. (Day, pp. 93–100, see footnote 2.)

such units as hours or pounds. Each quasifixed or fixed factor input coefficient is measured in acres or production units.[17]

The complementarity of various farm enterprises can be accounted for in the construction of these processes. Thus production of feed for livestock could be treated as an activity generating a supply of feed that could be sold or used as an input in a livestock-producing process. In the Delta Model[18] corn production for draft animal feed was treated as complementary to processes producing cotton by means of mule-powered field operations.

Net Returns

Expected net returns are measured in terms of expected gross returns per acre minus expected variable costs, assuming that these are evaluated at yields and input coefficients for normal weather. Thus, one obtains a measure of net returns expected with average weather. To account for the fact that farmers do not know the prices they will receive at the culmination of the crop year, a weighted function of preceding years' prices might be used. Current models use the simplest such expectation model, that is, prices lagged one year. This gives what net returns would have been in the preceding year if normal weather had prevailed as the measure of expected net returns per unit of each process for the given year.[19]

It should be noted that this approach regards production response as determined directly by net returns, and only indirectly by prices. All output prices and all input prices make their contributions indirectly through the actual decision variables. This not only conforms to the general theory of production but also to the facts of actual decision making.

The Objective Function

The objective function represents what farmers in a region are attempting to maximize. This function was discussed earlier in this paper and the characteristics of the decision process that appear to validate its application at the regional level were described. This function is the sum of the net returns expected per unit (acre) of each process multiplied by its corresponding process level. The aggregate of farmers' individual decisions is regarded as a set of regional process levels which maximizes the regional expected total net returns as just defined, subject to certain crucial limitations.

As we have seen, numerous constraints prevent the farmers in a region from achieving an ideal optimum in this sense. The way in which the objective function is used as a more homely guide to maximizing is now briefly described.[20]

Flexibility Constraints

We have shown that upper and lower bounds on the acreage of a given crop changing through time, are both a theoretical and a practical description of the way in which production changes are stabilized in the face of uncertainty. Such constraints limit flexibility in selecting process levels and thus account for the cautious way in which profit maximizing actually takes place. The maximum acreage allowed in the region for all processes producing the same commodity is some function of the actual total acreages of the crop in the past years and perhaps of other variables. The same is true of the minimum acreages allowed. I have used for such a relationship a constant percentage increase (or decrease) over the preceding year's actual acreage.[21] I have called these constant percentages flexibility coefficients, because they define the degree of flexibility in cropping changes that a given region can potentially manifest.

The total acreage of each commodity has an upper and lower bound for each year, defined by the preceding year's actual acreage, and by its upper and lower flexibility coefficients. More general formulations are currently being explored.[22]

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[17] Capacity utilization per acre is as difficult to define rigorously as capacity itself. Current results, however, suggest that this approach provides a useful empirical approximation.

[18] See Day, footnote 2.

[19] It is hoped that more realistic net returns expectation models will be included in future studies.

[20] We have already mentioned how planning over time may be included. The present remarks are limited to current model structuring.

[21] In this respect, my work is directly related to Henderson's (*5*).

[22] W. Neill Schaller, Farm Economics Division, Economic Research Service, in his Ph. D. thesis, "A Recursive Programming Analysis of Regional Production Response," recently submitted to the University of California, has constructed a recursive programming model in which the flexibility constraints include certain nonlinear functions of past acreages, the acreages of a given crop placed under controls, and the total available cropland. Further explorations, including yield variability, price or profit variability, other uncertainty measures, and "noneconomic" variables are planned. The crucial role which these constraints play and the complicated behavior phenomena they describe suggest that much research on their nature is needed.

This construction leads to distributed lags in price-adjustments. Last year's acreages account for the effects of all preceding production decisions, and therefore represent the accumulated effects of all preceding prices. Moreover, the effects on production of price changes in any given period are distributed over time because of the influence of the flexibility and capacity constraints. This observation applies to all production and investment variables included in the model.

Constraints on the Utilization of Variable, Quasifixed, and Fixed Factors

Maximum potential investment in a given technical stage or combination of quasifixed factors is assumed to bear some fixed relations to the preceding year's actual capacity of that stage. The constant percentages describing this relation are called investment coefficients and define the maximum rate at which growth in the particular capacity can occur. These coefficients represent the combined effects of growth in the off-farm industries producing the several machines involved, the learning process required by farmers for the adoption of methods previously not used by them, and finally, the uncertainty attached to the continued profitableness of investment in the particular technology stage.[23]

This hypothesis is analogous to the accelerator theory of investment frequently used in macroeconomic models. But it is a more flexible hypothesis, as actual investment is determined by the flexibility constraints as well as by these "maximal potential growth" constraints. Investment occurs at its maximum potential rate (the full acceleration case) only if limited profit maximizing justifies it. Actual investment may not reach this "acceleration" rate. In fact, disinvestment, or a decline in capacity utilization frequently occurs.[24]

[23] Note that this type of uncertainty differs from that described by the flexibility coefficients. This one applies to a given technique of production, of which there may be several for a given crop, while flexibility constraints apply to the total acreage of a crop.

[24] Unusual movements of capital into a region are not accounted for in this model, if by unusual we mean an amount exceeding the maximum predicted under the maximum potential growth principle. However, I have sketched out an interregional model that would predict the flow of capital among regions (4, pp. 108–125).

The limitations on the supplies of labor, fertilizer, and other variable factors at prices farmers are willing to pay have been accounted for by trends in past supplies, which determine upper bounds changing through time for the utilization of these factors during any one time period. Consequently, unlike the capacities of quasifixed factors, these factors are exogenous variables in the model.[25]

The only inputs regarded as fixed are the total acreages of the several soil classes or land types in the region available for production. An endogenous growth mechanism similar to that for quasifixed factors could be formulated for regions in which resources of this kind are underdeveloped.

Actual planned demand (utilization) for variable and fixed factors, investment in the several quasifixed factors, the planned level of each production process, is determined by the maximizing decisions. Thus, actual input utilization may or may not be determined at maximum potential levels.

The same distributed lag phenomenon described by the flexibility constraints applies to input utilization of all kinds. Current planned utilization depends not only upon last year's net returns but on all preceding years' net returns and so on all preceding years' output and input prices. It can further be shown that investment is greatest in those inputs whose marginal net-revenue or quasirents are highest. Consequently, the model is a formal description of Marshall's famous quasirent theory of investment and also a dynamic version of the closely related marginal productivity theory of investment.

Technological Change

Innovation as described can be introduced into the model by means of new production processes and new historically known or estimated capacities actually utilized during the innovation period. The new capacities, together with known (or estimated) capacities of old factors, form a new set of initial conditions for the model. The rate of adoption of these new processes is determined by exactly the same maximum potential growth principle described for old technologies.

[25] Current research is directed partly toward developing an endogenous mechanism for labor and fertilizer supplies.

The estimation of investment coefficients for newly innovated processes or new flexibility coefficients for newly innovated commodities is more difficult and less accurate than for those for older methods. This problem can be solved only by a deeper understanding of the forces determining investment patterns. Each innovation is in some respects unique, and it is doubtful whether empirical prediction of adoption rates can ever be more than approximated. However, it is likely that a detailed knowledge of past rates of adoption for a variety of new technologies can be used to estimate probable maximal potential growth for current or future innovations.

The Dynamics of the Current Model Structure

Two viewpoints can be taken in summarizing the model structure. The first regards the model as a chain of recursively dependent linear programming problems. The second regards it as a set of dynamic inequalities or *difference* inequations augmented by a dynamic "potential" function. We shall look at each view in turn.

First, the constraints for any one year are a function of the immediately preceding year's actual process levels, and the net returns are a function of the immediately preceding year's net returns. Thus for a given year, a linear programming problem exists which can be solved by the usual methods. One begins the model solution with a first or base year for which total acreages and input capacities are known (or estimated). These initial conditions provide the materials for a linear programming problem for the year following the base year. The solution gives the process levels and investment patterns for this second year and these in turn provide the information necessary to generate the next succeeding year's constraints. The process can be repeated for each year of the period under study. Because each year's programming problem depends upon the solution for the preceding year, we call the entire sequence of interdependent problems a recursive programming model.

Looked at in another way, the set of flexibility, investment, and fixed and variable factor constraints defines a set of dynamic inequalities in which the process levels of a given year are related to those of the preceding year by their various flexibility and technical coefficients and the exogenously determined variables. This results in a system of simultaneous difference inequations. Each such inequation defines a maximum positive or negative change in total acreage of a given crop, a maximum amount of investment, or a maximum amount of variable or fixed input utilization. Each of these is a potentially constraining factor, but none necessarily holds. Thus in itself, this set of inequations represents a variety of possible paths which production, investment, input utilization, and marginal returns may follow through time.

Such freedom exists in certain physical systems, also. The actual course of such systems is determined by a "potential" equation which must be satisfied at each point in time. The optimizing principle in our system is the potential equation which resolves our system of possible changes into a given system of actual or predicted changes. By means of it, the system of possible paths is resolved into a particular path.

From the philosophical viewpoint, the model has the following meaning. If free men with choices among alternative paths of action through time choose so as to do their best, as they currently view the best, their actions are predictable. Free choice is not inconsistent with determinate action. This is a commonplace fact. Faced with innumerable possibilities for the morrow, we really do something and do it as best we can, given our current values, myopically as they inevitably must be conceived.

Some Practical Implications

With a bit of reflection, some practical results are immediately forthcoming from the model presented. First the system of potential constraints may be resolved differently at different points of time. That is, during various periods of time, different sets of dynamic inequations will be equated. Or, to express the matter in another way, different potential constraints will be effective. This means, that at some times, certain input supplies may constrain production of a given crop while at other times, uncertainty, or the dominance of superior alternatives, may determine production. A different kind of model that accommodates only one or the other of several forces, such as certain inputs, or certain prices, might describe production response in one time span but not in others. This approach recognized this possibility at the outset and provides freedom for the model to de-

termine which among a variety of forces will actually influence production at a particular time and under particular economic conditions.

Second, as the response of a given crop to its own price is conditioned by all other input and output prices in addition to the possible constraining effects of uncertainty and input supplies—the effects of which may change through time—we can anticipate that price elasticities of supplies will vary considerably from period to period. Further, they are undoubtedly not invariant to short-run changes in price or other variables and consequently are not valid for estimating short-run effects of price changes. In fact, the short-run (as well as the long-run) supply curves for a given commodity are likely to be highly irregular step functions, meaning that a percentage change in output in response to a percentage change in price will vary considerably at different price levels.

Third, the frequently observed phenomenon of increased production of a commodity whose price is falling follows naturally from our considerations. Relative net returns to the finite number of production alternatives considered by farmers in their plans take discrete "jumps" as prices vary. This allows a given commodity to retain its attractiveness even as its own price falls. For the converse reason, production of a crop may contract even though its price is rising!

We reach the somewhat ironical conclusion that not only is such a phenomenon consistent with sequential optimizing behavior, but that if demand is stable it may be expected to occur frequently. When statistical models of price response are rejected because of this "inverse response relation," the "common sense" application of the optimizing principle leads to the wrong conclusion for the right reason!

Finally, it can be shown that investment and rate of adoption patterns may frequently be determined by forces other than their own maximum potential growth, particularly when they contribute to a high proportion of output. Uncertainty, if not declining profitableness, will set in eventually, and will determine investment patterns to a considerable degree. Thus the familiar **S**-like curve is traced through time and derived from the various response forces. It is not assumed as a trend.

On the Pure Theory of Recursive Programming

Certainly, the model just described is an imperfect description of actual production response in agriculture. The current model structure has many limitations, despite the fact that empirical tests indicate its practical usefulness.[26] It is the result of the "judicious compromise" between theoretical understanding and operational possibility described earlier. Further research will remove some of the limitations. Detailed comparison of the model estimates with actual data and other models of production response will be helpful. In any event, it is clear that recursive programming models contribute to theory and understanding the decision process in atomistic markets.

From this viewpoint, primary characteristics of the method are, first, its formal description of optimizing over a limited time horizon on the basis of knowledge gained from producers' past experience, and second, the sequential regeneration of the planning problem. A recursive programming problem is not solved by a single decision that claims to determine what action will be optimal in each planning period within the time horizon, as do current versions of "dynamic programming." Instead, it recognizes that plans for the future must be changed during each suceeding planning period to account for the actual history of economic variables.

The solution of such a system does not determine an optimal path leading to well-conceived terminal objectives (*6*). Rather, it determines a path in which each step is the result of an attempt at optimal action, but in which the terminal objectives toward which the step is taken are also changing as a result of an actual history that can never be fully determined by any one optimal plan. This model's decision process never ends. Just like world decision problems of any kind, it must continually be reformulated to account for newly acquired information.

Recursive programming reflects an essential aspect of the real economic world. Further cultivation of its particular empirical structure may be expected to bear fruitful results, both for the-

[26] In the sense that the percentage variation in actual crop acreages for a 20-year period explained by the model is quite high: about 85 to 95 percent for five major crops produced in the Mississippi Delta.

oretical understanding of production response and for predicting response to specific forces acting on production.

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Book Reviews

Business Cycle Indicators: **Vol. I,** ***Contributions to the Analysis of Current Business Conditions; Vol. II, Basic Data on Cyclical Indicators.***

By Geoffrey H. Moore, Editor. Princeton University Press. Vol. I. 757 pages. 1961. $12.50. Vol. II. 179 pages. $4.50. The set, $15.00.

ECONOMIC FORECASTING is a precarious occupation. Yet if decision makers are to formulate programs, estimates must be made of future events. If businessmen were to decide on plant investment, production schedules, inventory policy, and other programs without attempting to narrow the domain of uncertainty caused by fluctuating levels of business activity, we would have little hope of obtaining results that would be "good" or, even more, "optimal."

Two techniques among those most widely used in general business forecasting are the approach of business cycle indicators and that of the econometric model. *Business Cycle Indicators* treats the former technique thoroughly. The econometric approach has yet to receive definitive treatment.

The "indicators" approach in large part is a culmination of Wesley Claire Mitchell's pioneering work into the nature and causes of economic fluctuations. For more than a quarter of a century, Mitchell directed the National Bureau of Economic Research (NBER) in its studies of business cycles. The editor notes Mitchell's contribution in this wholly fitting evaluation of his research in the field: "His role can be gratefully acknowledged. It can never be evaluated."

Perhaps the best way to convey the contents of these works and to summarize the "indicators" approach to cyclical analysis is to begin with the NBER definition of a business cycle. The etymology of the definition leads back to Mitchell's early work *Business Cycles: The Problem and Its Setting* (NBER, 1927) and a modified definition in Arthur F. Burn's and Mitchell's *Measuring Business Cycles* (NBER, 1946). It runs as follows:

> "Business cycles are a type of fluctuation found in the aggregate economic activity of nations that organize their work mainly in business enterprises: A cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic; in duration business cycles vary from more than one year to 10 or 12 years; they are not divisible into shorter cycles of similar character with amplitudes approximating their own."

Armed with this working definition, the purpose of the NBER work on business cycles is seen as an attempt to "identify the cycles of historical record and study their characteristics" (*Measuring Business Cycles*, p. 8) so that a selection can be made of statistical series that are good forecasters or indicators of the short-run cyclical trends of business activity.

As a result of testing more than 800 statistical series for the stability of their relationship to the business cycle, the NBER currently lists 26 series as being of particular value in analyzing cyclical trends in the economy. These series are grouped into 12 leading, 9 roughly coinciding, and 5 lagging series according to their typical time sequence in the business cycle.

In addition, the NBER has developed measures to aid in assessing the magnitude of recession and recovery movements. The best known measure, the diffusion index, expresses for a given group of economic series the proportion which has risen over given intervals of time. It indicates, therefore, how widespread an expansion or contraction is at any given time. Empirically, their movements have been found to lead turns in measures of aggregate economic activity by 6 months to a year.

A recounting of the criteria used for selecting the NBER statistical indicators, and testing and classifying them comprise the central theme of the 10 essays included in Part I of Volume I.

An examination of the cyclical behavior of particular types of leading indicators is the common link for the six essays brought together in Part II of Volume I. The essays were selected on the basis that they treat primarily one or another of

the types of leading indicators or diffusion indexes discussed in Part I. Although these essays are lengthy, detailed, and varied, a brief summary of Victor Zarnowitz's piece on "The Timing of Manufacturers' Orders During Business Cycles" may serve to give the reader some idea of the contents of this section.

After formulating a typical sequence of events in the response of an industry to cycles in ordering, Zarnowitz analyzes a number of new orders series for their correspondence with peaks or troughs in the vicinity of a business upturn or downturn. He concludes that manufacturers' new orders, especially those for durable goods, have merit as leading indicators of revivals and recessions in general business. Substantial shortcomings arise, however, because leads are far from uniform in length and often rather short. In addition, data on new orders frequently exhibit irregular movements which can be misleading for forecasting or identifying turns in the business cycle. Zarnowitz examines the properties of various devices, such as cumulation, weighted graduation, and averaging the duration of movements in the series used for diffusion measurements, for reducing irregularities with a minimum loss in timeliness.

The concluding section of Volume I describes the role of the electronic computer in constructing the analytical measures treated in this volume. The electronic computer made feasible the many burdensome operations necessary to fashion the indicators approach into a useful, current analytic measure. The elimination of seasonal movement, trend calculation, and measurement of cyclical amplitudes, rates of change, recovery and recession patterns, and diffusion measures are extremely time-consuming. Because of their laboriousness, the expedient approach often entails ignoring seasonal variation and cyclical factors and making same-month-year-ago comparisons. The limitations of this approach and the aid to the current use of indicators provided by electronic computers are thoroughly treated in two essays by Julius Shiskin. In addition, Moore covers methods suitable for adjusting the amplitudes and summarizing the behavior of a collection of indicators.

Volume II of *Business Cycle Indicators* presents the basic data upon which the contributions of Volume I rest, as well as the seasonally adjusted figures. It provides sources and brief descriptions of the historical data; these enable interested readers to update the series beyond 1958, the terminal date for the series published in the volume.

Martin J. Gerra, Jr.

Oligopoly and Technical Progress

By Paolo Sylos-Labini. Harvard University Press, Cambridge, Massachusetts. 206 pages. 1962. $4.75.

THE THEORY OF OLIGOPOLY is in a fluid, not to say chaotic, state, according to Sylos-Labini in his readable discussion of micro-theory, macro-behavior, and public policy. His contention that there is no marginalist solution for the oligopoly problem will be refreshing to those who doubt the universal applicability of the myopic optimality conditions of static, micro-theory.

Sylos-Labini feels the overthrow of marginal theory follows from (1) abandoning the law of diminishing returns, (2) working with discrete rather than continuous variables, (3) focusing entrepreneurial attention on the behavior of other oligopolists rather than on consumer behavior, and (4) maximizing long-run rather than short-run profits. He evidently fails to notice that the overthrow follows directly from his steadfast [and justifiable] refusal to assume perfect knowledge on the part of oligopolistic entrepreneurs.

The chapters on firm theory develop a reasonable and practical approach to price fixing and concentrate on conditions of entry. The equilibrium firm organization, he finds, depends on initial firm and industry organization as well as on which entrepreneur reacts first. While several attainable equilibria may exist for a firm or an industry out of adjustment with its environment, each, when reached, can be stable. A reversal in environmental conditions need not induce a corresponding reversal in firm response.

The discussion of the distribution of income between agriculture and industry will be especially interesting to readers of this journal, as will the exposition of how the fruits of technical progress may lead to stable prices, higher wages and profits, unemployment and stagnation in a world of concentrated oligopolies. Growth and full employment in a developed economy are shown to depend on an effective demand maintained by government spending, principally for military purposes.

This enlightening discussion is not a basic text in oligopoly theory, but rather a valuable source of insights into the workings of modern market structures. The book is highly readable with a

few simple equations and numerical examples but with no graphs. It belongs on the reading list of economists interested in the consequences of industrial concentration as well as of those who still believe that competition rules the markets.

Clark Edwards

An Introduction to Econometrics

By Lawrence R. Klein. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. 280 pages. 1962. $7.50.

THIS BOOK IS INTENDED to be a preface to the author's *Textbook of Econometrics*. The book is just what has been needed in econometrics. It is non-technical and tells the reader what econometrics is all about without getting into the highly mathematical and statistical problems of estimation and computation.

The book, however, is not devoid of mathematics or statistics. A knowledge of elementary algebra and a first course in statistics will provide the reader with sufficient background to master the technical aspects.

The topics of statistical demand analysis, statistical production and cost analysis, distribution of income and wealth, and statistical models of economic growth and trade cycles are covered. Numerous examples are presented throughout the book. The large number and variety of examples give to those who do not have a working knowledge of econometrics an appreciation of the role that mathematics and statistics play in the measurement of economic relationships and some of the problems involved in these measurements.

The author could have improved his presentation through a greater use of graphic analysis. In this way, the mathematical notation employed in the text would be a complement to the graphics. For example, a graphical presentation of cobweb models would have more clearly illustrated the dynamic nature of the models and the inherent stability (instability) characteristics of the model than just an algebraic presentation of the demand and supply equations and demand-supply identity. Since most students learn their economic theory through geometric presentations, a greater use of graphics would have made the exposition more familiar to readers of this book than the use of algebraic representation of economic relationships and models.

The objective of this book, in the author's words, is to give ". . . people an appreciation of modern econometrics without going into the technical details of how to go about doing professional research in the field." The author is successful in achieving this objective.

Martin E. Abel

The Cattle Kings

By Lewis Atherton. Indiana University Press, Bloomington. 308 pages. 1961. $6.95.

CATTLE RAISING, particularly on the open range, has been more studied, and at the same time, more romanticized, than any other aspect of agricultural history. Beginning in 1930 with Everett E. Dale's *The Range Cattle Industry*, sponsored by the Bureau of Agricultural Economics, a number of notable studies have traced the development, financing, and decline of the Western range cattle industry, and have delineated the place of the cowboy, both in reality and in folklore. Now, Lewis Atherton, distinguished historian at the University of Missouri, has written the history of the cattlemen. This fascinating, scholarly study of the rugged individuals who dominated the industry will take its place with other basic studies of the range cattle industry and of the West.

The economist will find this book of importance in assessing the land, labor, and capital which went into the range cattle industry. A combination of factors, which Professor Atherton traces, gave the Great Plains region a competitive advantage in beef production after the Civil War. These included cheap land for grazing when the public domain was opened, better marketing facilities through railroads and the invention of the refrigerator car, and a flow of capital into Western ranching when British corporation laws were modified in the direction of investment trusts.

The opportunity to make a fortune with this favorable combination of circumstances was seized by a number of enterprising, self-reliant young men—most of them between 25 and 35 years of age. The individual cattleman had to be a good businessman with a flair for taking a chance. Generally, individuals were more sucessful than were the large companies. This was particularly notable after the hard winter of 1886–1887, which marked the trend away from large herds ranged with little care over the public domain to smaller, controlled herds ranged on owned or leased lands.

This study may provide some clues to the problem of economies of size in agriculture.

Mr. Atherton has given the historian, economist, and general reader a brilliant, yet scholarly, account of one aspect of the western cattle industry which has been neglected. His book will be of basic importance for years to come.

Wayne D. Rasmussen

A Study of Managerial Processes of Midwestern Farmers

Edited by Glenn L. Johnson, Albert N. Halter, Harald R. Jensen, and D. Woods Thomas. Iowa State University Press. 221 pages. 1961. $4.95.

MUCH OF THE VALUE of teaching and research done by agricultural economists, particularly production economists, is in its ultimate application by farm managers to real decision problems. This being the case, it is surprising, at least at first glance, that so little has been done to explore and document the managerial processes of farm managers.

Most research on the managerial process has been almost exclusively conceptual or exclusively empirical; seldom have the two phases of investigation been integrated. But this book reports a study that is both conceptual and empirical. It contains a wealth of information of both types and its provides a test situation for numerous hypotheses about the managerial process. It is largely a report of specific research undertakings; it is not, nor can it be expected to be, a definitive treatment of the managerial process of farmers.

Probably because the book has several authors and, in large part, is a research report or a series of such reports, its lacks continuity and ease of transition from one topic to another. Chapter topics include an introduction, sources of information used by farmers, knowledge situations, analytical processes in farm management, formulation of expectations, decision making, and utility of gains and losses. In addition, there are four final chapters by Glenn Johnson, three of which are largely conceptual; the fourth sums up major findings of the study.

A significant addition is an appendix containing a questionnaire used in interviewing more than a thousand Midwest farmers, and instructions to enumerators. The appendix helps the reader to evaluate the study results in view of the specific questions asked.

Much of the book follows the outline of earlier writings by the senior author and Cecil B. Haver on the same subject. These earlier writings were largely conceptual—this empirical study of Midwestern farmers undertakes to verify, to strengthen, or to refute this conceptual framework.

Although the book contains elements of conceptualization, hypothesizing, and empirical testing, these are not always well integrated. Chapter 10, for example, suffers from this lack. The conceptual nomenclature of resource fixity in this chapter appears to overwhelm the limited empirical results relevant to this subject obtained in the study. This is not to be critical of the quality of either, per se, but only to question the relative space devoted to each. Again, this disparity between rationalism and empiricism probably has its origin in the specific research conducted and available for reporting, rather than in the philosophical research position of the author.

Individual readers will find some chapters more or less useful, depending on their interest in such topics as communications, formulation of expectations, the measurement of utility functions, insurance, and so on. As one reads through the book it becomes increasingly obvious why this important subject matter area had not previously been more completely researched. Problems of measurement, comparability, consistency, and so on are all exemplified by research reported in the several chapters of this volume.

Its greatest usefulness will be to provide a reference for much needed spadework research on this topic. In addition to supplying answers to some specific questions—34 results and conclusions about the managerial process are listed—the work provides much information of value in suggesting and guiding additional and more detailed research efforts on well delineated subtopics.

Anyone wanting to explore the managerial processes of farmers would be well advised to devote the time necessary to reading sections of this book relevant to his interests. The time and effort spent by the authors in preparation of the volume resulted in furthering our knowledge of the subject covered. But anyone who lacks a genuine interest in the subject will find the book not easy to read.

W. B. Sundquist

Selected Recent Research Publications in Agricultural Economics Issued by the United States Department of Agriculture and Cooperatively by the State Universities and Colleges[1]

ALLEN, M. B. AND WILLIAMS, F. W. THE SOUTHEASTERN VEGETABLE PROCESSING INDUSTRY: RAW PRODUCT PROCUREMENT, 1960. U.S. Dept. Agr. Mktg. Res. Rpt. 560, 11 pp. Aug. 1962. (Ga. Expt. Sta. cooperating.)

This is the second report of a study on the economic potentials of processing as an outlet for vegetables produced in the Southeast. Canners and freezers in seven States processed more than $16 million worth of fresh vegetables in 1960. Plants in Tennessee, Georgia, and Florida processed 83 percent of the total volume.

BUTZ, W. T. GEOGRAPHIC STRUCTURE OF MILK PRICES, 1960–61. U.S. Dept. Agr., Econ. Res. Serv., ERS–71, 11 pp. Aug. 1962.

Comparison of price maps of dealers' buying prices for fluid milk demonstrated a closer alignment of prices between distant markets and major supply areas during 1960–61 than in either 1953–54 or 1957–58. As in the earlier years, the 1960–61 price surface identified the Atlantic Coastal States as relatively high-priced markets. Buying prices in eastern markets were generally lower in 1960–61 than in 1957–58. The zone of lowest prices—less than $4.00 per 100 pounds—was noticeably smaller in 1960–61 than during 1957–58, reflecting higher prices in northern Iowa, northern Illinois, and southern Wisconsin.

CHRISTIANSEN, J. R., COWHIG, J. D., AND PAYNE, J. W. EDUCATIONAL AND OCCUPATIONAL ASPIRATIONS OF HIGH SCHOOL SENIORS IN THREE CENTRAL UTAH COUNTIES. Brigham Young Univ. Social Sci. Bul. 1, 32 pp. June 1962. EDUCATIONAL AND OCCUPATIONAL PROGRESS OF RURAL YOUTH IN UTAH: A FOLLOW-UP STUDY. Brigham Young Univ. Social Sci. Bul. 2, 13 pp. Aug. 1962. (Econ. Res. Serv., cooperating.)

These cooperative studies were intended to determine (1) the social factors related to the plans of rural youth in three Utah counties to attend college, (2) the characteristics of parents of rural boys and girls who are considering college, (3) background factors related to the decisions of rural youth to enroll in college, and (4) the relationship between plans and actual behavior. Among findings: 35 percent of the youths who did not attend college and most who dropped out of college gave "lack of finances" as their reason; only 5 percent of the boys in high school named farming as their preferred future occupation—most named white-collar jobs; and, among young men not in school a year after high school graduation, about a fifth were working only part-time and none were employed in the white-collar jobs they aspired to in high school.

[1] State publications may be obtained from the issuing agencies of the respective States.

CHRISTIANSEN, R. A., HARTWIG, P. A., AND STANIFORTH, S. D. BANK CREDIT FOR AGRICULTURE IN WISCONSIN. Wis. Agr. Expt. Sta. Bul. 557, 15 pp., illus., June 1962. (Econ. Res. Serv. cooperating.)

Banks serving agriculture in Wisconsin increased their farm loan volume more than 70 percent from 1950 to 1960, though the proportion of farm loans to total loans declined throughout the State. Today more loans are being made to finance farm machinery and livestock, and fewer to finance farm real estate, reflecting recent shifts in the financial structure of Wisconsin farms.

COWHIG, JAMES D. FARM OPERATOR LEVEL-OF-LIVING INDEXES FOR COUNTIES OF THE UNITED STATES, 1950 AND 1959. U.S. Dept. Agr. Statis. Bul. 321, 64 pp., illus. Sept. 1962.

Five items in the index formula were: (1) Average value of sales per farm, (2) average value of land and buildings per farm, (3) percentage of farms with telephones, (4) percentage of farms with home freezers, and (5) percentage of farms with automobiles. For each State, the index was substantially higher in 1959 than in 1950, but the relative position of the States had changed only slightly. The major change in the rank of States on the index was the higher position of States in the Mountain and Pacific divisions in 1959 than in 1950 and the correspondingly lower rank of States in the New England division. Arizona, California, Nevada, and Iowa ranked highest on the level-of-living index in 1959.

CROSSWHITE, W. M., AND VAUGHN, G. F. LAND USE IN THE RURAL-URBAN FRINGE: A CASE STUDY OF NEW CASTLE COUNTY, DELAWARE. Del. Agr. Expt. Sta. Bul. 340, 28 pp., illus. July 1962. (Econ. Res. Serv. cooperating.)

This study was initiated to provide information for the regional planning program of northern New Castle County, Delaware. Land use in this county is becoming increasingly urban. Careful planning for the future becomes mandatory as urban demand for land increases and the availability of open land decreases. Since 1950, urbanization has brought land prices in rural districts to the approximate level that exists close to cities. But property taxes levied against land and improvements are low. More than 12 percent of the acreage under study was tax exempt.

DUBOV, I., AND ANDRILENAS, P. A. AGREEMENTS FOR PRODUCING AND MARKETING TENNESSEE HOGS AND FEEDER PIGS. Tenn. Agr. Expt. Sta. Bul. 335, 15 pp. Nov. 1961. (Econ. Res. Serv. cooperating.)

Farm management and farm marketing practices of Tennessee producers of hogs in areas where vertical integration is likely to occur were studied to determine the

incidence, nature, and outlook for contractual arrangements and agreements in the areas. Industry sources estimate the total number of hogs produced in Tennessee under agreements at less than 1 percent of the total for the State. Contract production of hogs is still in an experimental stage so far as provisions of agreements are concerned. The lack of uniformity in the agreements covered in this report suggests that, as the number of contractees increases, contractors may find it desirable to standardize their contracts.

GARLOCK, F. L., AND OTHERS. THE BALANCE SHEET OF AGRICULTURE, 1962. U.S. Dept. Agr., Agr. Inform. Bul. 270, 24 pp., illus. Aug. 1962.

Equities of farm operators and other owners of farm assets reached $179.6 billion on January 1, 1962, up $5.1 billion from a year earlier. Gross farm income of about $40 billion was nearly $2 billion higher in 1961 than in 1960. Although expenses rose, realized net income of farm operators increased by more than $1 billion, close to 10 percent.

GREENE, C. H., AND DAVIS, G. B. LABOR PERFORMANCE STANDARDS IN SEED WAREHOUSING. Oreg. Agr. Expt. Sta. Spec. Rpt. 135, 19 pp. Aug. 1962. (Econ. Res. Serv. cooperating.)

This report, dealing with labor and equipment performance standards, is the first of a series on costs and efficiencies in seed processing. A later report will consider equipment and facilities costs. These and time standards will be used to synthesize models of seed processing plants to determine what effect length of season, annual volume, methods used, and kinds of seed have on costs of processing.

HANSING, F. D. CONTRACT EGG PRODUCTION AND USE OF CREDIT BY SELECTED EGG PRODUCERS IN MISSISSIPPI. Miss. Agr. Expt. Sta. Bul. 644, 16 pp. April 1962.

The rapid increase in egg production since 1955 has undoubtedly been due in part to the development of egg contracting, first introduced in Mississippi about 1957. It has brought larger-size units of production, lower costs, and an expanded market. If development continues in this direction, capital requirements of egg producers in Mississippi will increase, and local credit institutions will be requested by such producers to provide additional financing.

HARP, H. H., AND DUNHAM, DENIS F. CONVENIENCE FOODS IN THE GROCERY BASKET. U.S. Dept. Agr. Mktg. Bul. 22, 8 pp. Sept. 1962.

Many convenience foods (defined as foods that before retailing have undergone some preparation ordinarily done in the home) save money as well as time and energy. Frozen orange juice concentrate, instant coffee, and frozen chicken chow mein, for example, are less expensive than their "home prepared" counterparts.

JONES, H. B., AND THOMPSON, J. C. MARKETING COSTS AND LABOR PRODUCTIVITY IN COMMERCIAL EGG PACKING PLANTS. Ga. Agr. Expt. Sta. Bul. N.S. 93, 51 pp. June 1962. (Econ. Res. Serv. cooperating.)

Presents an analysis of marketing costs and labor efficiency based on operating conditions found in 17 commercial egg packing plants in 1959. Owners, directors, and management of egg marketing firms will find in this report: (1) A framework for evaluating costs in their present egg handling operation, (2) data showing the potential of labor if expansion or reorganization is contemplated, and (3) guides for firms or groups interested in setting up an egg packing operation either as an independent company or as a subsidiary enterprise.

MANCHESTER, ALDEN C. THE ORGANIZATION OF THE NEW YORK CITY WHOLESALE FRUIT AND VEGETABLE MARKET. U.S. Dept. Agr. Mktg. Res. Rpt. 542, 36 pp. June 1962. THE ORGANIZATION OF THE WHOLESALE FRUIT AND VEGETABLE MARKET IN DALLAS, FT. WORTH, HOUSTON, LITTLE ROCK. U.S. Dept. Agr. Mktg. Res. Rpt. 558, 57 pp. Aug. 1962. THE ORGANIZATION OF THE WHOLESALE FRUIT AND VEGETABLE MARKET IN PITTSBURGH. U.S. Dept. Agr. Mktg. Res. Rpt. 557, 26 pp. Aug. 1962. THE ORGANIZATION OF WHOLESALE FRUIT AND VEGETABLE MARKETS IN DENVER, SALT LAKE CITY, EL PASO, ALBUQUERQUE, AND BUTTE. U.S. Dept. Agr. Mktg. Res. Rpt. 541, 68 pp. June 1962. (Agr. Expt. Stas. of Mont., N. Mex., and Utah cooperating.)

These 4 are the latest in a series describing wholesale fruit and vegetable markets in more than 50 U.S. cities.

MCCONNELL, D., SCHMIDT, J. R., STANIFORTH, S. D., AND CHRISTIANSEN, R. A. RELATIVE PROFITABILITY AND ORDER OF ADOPTION OF SOIL CONSERVATION PRACTICES. Univ. Wis. Dept. Agr. Econ. Res. Bul. 237, 40 pp., June 1962. (Econ. Res. Serv. cooperating.)

On a representative 180-acre farm in southwestern Wisconsin, the most profitable single conservation practice is estimated to be terracing in combination with an optimum livestock program, producting from $350 to $3,076 more in net farm income than any of the other 7 practices considered. By combining the five most profitable practices, net farm income would be still further increased.

REESE, R. B. AND ADELSON, SADYE F. FOOD CONSUMPTION AND DIETARY LEVELS UNDER THE PILOT FOOD STAMP PROGRAM, DETROIT, MICH., AND FAYETTE COUNTY, PA. U.S. Dept. Agr., Agr. Econ. Rpt. 9, 17 pp. June 1962. (Econ. Res. Serv. and Agr. Res. Serv. cooperating.)

The nutrition of needy families and the distribution of farm products have both improved in these two areas since the Federal Food Stamp Program coupons were introduced there in the summer of 1961.

ROGERS, G. B., AND BARDWELL, E. T. REDUCING COSTS OF HANDLING AND HAULING LIVE CHICKENS FROM FARMS TO PROCESSING PLANTS. U.S. Dept. Agr., Econ. Res. Serv., ERS–81, 12 pp. Aug. 1962. (N.H. and Mass. Agr. Expt. Stas. cooperating.)

Preliminary results are given of the cost phase of a study of handling and hauling live poultry from farm to processing plants in New England during 1957–59. In 1957 it cost 330 processing plants $4.6 million to bring in 470 million pounds of poultry from farms. The present procurement system is characterized by excess capacity and duplication of travel and expense.

SHAPIRO, HARVEY. TAXATION OF TANGIBLE PERSONAL PROPERTY USED IN AGRICULTURE. U.S. Dept. Agr., Econ. Res. Serv., ERS–86, 17 pp. Aug. 1962.

In Maine, houses are exempt from personal property taxes until they are 6 months old; in New Hampshire, they become taxable at 24 months. Tractors are taxed in 34 States; 7 States completely exempt farm machinery and tools. These and other State-to-State differences in tax treatment of farm personal property are discussed. Exemptions by State and region are compared in the following categories: Farm tools and machinery, livestock, poultry, growing crops, stored crops and seed, tractors, and farm trucks and automobiles used in agriculture.

SOXMAN, R. C., AND HOLDER, S. H., JR. OFFICIAL SPOT COTTON QUOTATIONS, WHERE AND HOW QUOTED. U.S. Dept. Agr. Mktg. Res. Rpt. 547, 68 pp. June 1962.

Recommendations for improving spot cotton quotations in the 14 designated cotton markets include eliminating several markets, using weights, based on relative quantities of cotton produced in the regions and handled by individual markets, to average the quotations, and limiting markets to quoting only those qualities handled within the market. The 14 markets in 1959–60 were not well balanced as to size, overall suitability, and geographical representation.

TOWNSHEND-ZELLNER, NORMAN. THE CALIFORNIA RAISIN INDUSTRY: PRICES, RETURNS, ECONOMIC ADJUSTMENTS. U.S. Dept. Agr., Agr. Econ. Rpt. 11, 54 pp. July 1962.

Studies recent developments in the California raisin industry (1) to determine the effects of industry organization and marketing practices on prices and returns, and (2) to provide information to help solve problems generated by these developments.

TROTTER, W. K., POATS, F. J., AND WOLFF, I. A. NEW INDUSTRIAL CROPS—SOME ECONOMIC CONSIDERATIONS. U.S. Dept. Agr., Agr. Econ. Rpt. 10, 45 pp., illus. June 1962.

Economic potentials of three types of new industrial crops are evaluated: Annual pulp crops to supply raw material for the pulp and paper industry, oilseeds that are sources of unique industral oils, and guar, a summer legume and source of natural gum Pulp crops studied included kenaf, sesbania, crotalaria, sorghum, and okra. Oilseeds studied included high erucic acid oilseeds, high petroselinic acid oilseeds, cape marigold, Indian ironweed, and balsam apple.

VAN ARSDALL, R. N. THE ECONOMIC VALUE OF MANURE FROM CONFINEMENT FINISHING OF HOGS. Ill. Agr. Expt. Sta. Bul. 687, 20 pp., illus. May 1962. (Econ. Res. Serv. cooperating.)

Confinement systems of hog production on 72 Illinois farms on which hogs were grown and finished in confinement during 1959 and 1960 are evaluated. Three methods of handling hog manure are discussed: (1) The use of straw or other dry bedding material and the subsequent handling of manure as a solid; (2) the confinement of hogs on a bare concrete floor, handling the manure as a liquid to be stored and later applied to cropland; and (3) the handling of manure as a liquid to be discarded in a manure lagoon.

VLASIN, R. D., PENDLETON, W. C., AND HEDRICK, J. L. THE EFFECTS ON FARM OPERATING UNITS OF LAND ACQUISITION FOR CONTROLLED-ACCESS HIGHWAYS. U.S. Dept. Agr., Econ. Res. Serv., ERS–69, 80 pp. June 1962.

Reports a 3-year history of 80 farms crossed by a 33-mile segment of Iowa Interstate Route 35 south of Des Moines. Constructed on new rights-of-way, it took all or part of six sets of farm buildings and just under 7 percent of the farmland in the 80 operating units sampled. After 3 years, more than half the farms had failed to regain their original size. In spite of help to farmers from the Iowa Highway Commission, the highway substantially increased the scattering of fields in individual farms crossed.

WITTE, A. M., SOLBERG, E. D., AND MARTIN, L. R. LAND-USE PLANNING AND ZONING IN ARKANSAS RURAL AREAS: LEGAL AND ECONOMIC ASPECTS. Ark. Agr. Expt. Sta. Bul. 657, 76 pp., illus. June 1962. (Econ. Res. Serv. cooperating.)

This is a survey of the role of land in Arkansas' economic development, and how planning and zoning powers can be used to insure its best use.

WOOTEN, H. H., GERTEL, KARL, AND PENDLETON, W. C. MAJOR USES OF LAND AND WATER IN THE UNITED STATES, WITH SPECIAL REFERENCE TO AGRICULTURE SUMMARY FOR 1959. U.S. Dept. Agr., Agr. Econ. Rpt. 13, 54 pp. July 1962.

During the last 30 years, 30 million acres or more of poorly adapted cropland have been shifted to forest and pasture, while 10 million acres of new land have been brought into cultivation. This report is one of a series published at 5-year intervals that show acreages of land used for crops, pasture and range, forest, and other purposes. Information on acreages irrigated and dry farmed, acreages drained, and other water-use practices.

Statistical Compilations

CONSERVATION NEEDS INVENTORY COMMITTEE, U.S. DEPARTMENT OF AGRICULTURE. BASIC STATISTICS OF THE NATIONAL INVENTORY OF SOIL AND WATER CONSERVATION NEEDS. U.S. Dept. Agr. Statis. Bul. 317, 164 pp. Aug. 1962.

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STRICKEN, P. E., AND HINSON, W. C. EXTENT OF SPRAYING AND DUSTING ON FARMS, 1958 WITH COMPARISONS. U.S. Dept. Agr. Statis. Bul. 314, 28 pp., May 1962.

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